

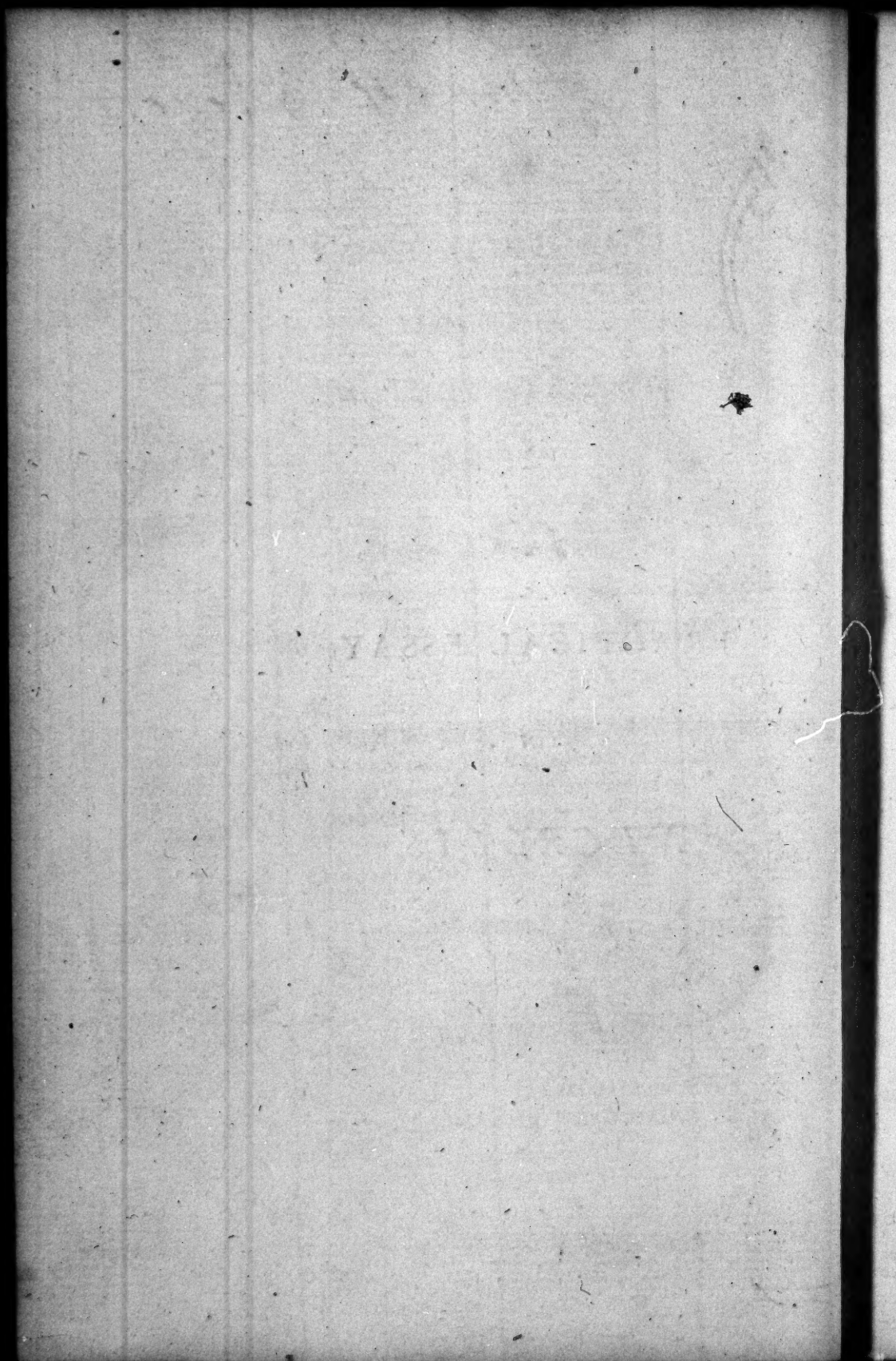
John F. Devore —

A

PRACTICAL ESSAY

ON

NECROSIS.



A
PRACTICAL ESSAY
ON A CERTAIN
DISEASE OF THE BONES,
TERMED
NECROSIS.

ILLUSTRATED WITH SIX PLATES.

By JAMES RUSSELL, F. R. S. EDIN.
FELLOW OF THE ROYAL COLLEGE OF SURGEONS,
AND ONE OF THE SURGEONS TO THE
ROYAL INFIRMARY OF EDINBURGH.



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1877

ON A CERTAIN

DISEASE OF THE BOWEL

THE

W.C. 1777

ILLUSTRATED WITH SIX PLATES

BY JAMES RUSSELL, F.R.S. EDIN.

PHYSICIAN OF THE ROYAL COLLEGE OF PHYSICIANS
AND OF THE ROYAL INFIRMARY, EDINBURGH
F.R.S. EDIN.



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PRINTED BY J. & J. R. SMITH, EDINBURGH
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AN ESSAY ON NECROSIS.

SECTION I.

General Remarks, and Description of Appearances.

THE power of reproduction which nature possesses, displays itself in a great variety of morbid cases, but in none of them more remarkably than in a certain disease of the bones, termed *Necrosis**.

A

In

* The import of the term *Necrosis*, is more fully considered in the explanation which is annexed to the plates. So that, if any difficulty or ambiguity arises from the want of a particular definition of the term, it will be of advantage to consult the explanation of the plates, previous to the perusal of the Essay.

In this disease new parts are formed in a very curious manner, and with a degree of perfection altogether extraordinary. For after the entire loss of the original bone, the formation of a substitute one enables the patient to perform all the usual functions of the limb, without any sensible inconvenience or difficulty; and it is a very remarkable circumstance, that, in favourable instances of the disease, the power of motion is preserved during all the time these changes are going on. Consequently the new bone must have begun to grow, and must have acquired firmness, before the old bone separates and comes away, else there must be an interval of time at which the power of motion would be entirely suspended. Since it is plain that if the original bone were to separate while

while the incipient substitute was still soft and flexible, the limb could perform no motion which required the assistance of a solid support, and would therefore be completely useless.

In this respect, then, a case of Necrosis differs from all other cases of renovation, since in every one of them the newly formed parts begin from the first to fill up the exact space which the original parts before occupied, and which had previously been left empty by their destruction or removal.

These leading facts explain many important circumstances in the history of the disease.

First, The new bone must be formed and consolidated before the old one separates, otherwise (as has already been observed) the patient could not continue to use his limb during all the time of the cure ; as it must become flexible and useless the moment the old bone separated, unless a new one had been previously formed to serve the same purposes.

Secondly, Another consequence of the formation of the new bone anticipating the separation of the old, is that the new bone should surround and include the old one. For since the lifeless portion of bone completely occupies the space between the two living extremities, it is impossible for the newly formed bone to connect the extremities directly. The connection can alone be completed by
the

the new bone passing over the old bone from the one end to the other, and attaching itself to the portions which still remain alive; and this actually is the course which nature follows in a case of Necrosis.

Thirdly, It is a plain inference from the last deduction, that the new bone must be larger than the old one; for the new bone is formed upon the outside of the old bone, consequently even the internal dimensions of the new bone must exceed the external dimensions of the old one; so that its outside measure will be much greater. Upon this account, the affected limb will, after the cure is complete, be larger, clumsier, and less shapely than the other limb; but the length of it remains unaltered, because

the old bone retains its attachments, while the rudiments of the new bone are lying on the outside of it, and connecting the extremities of the old bone by a rigid mass equal in length to the portion which was removed or destroyed.

We may therefore consider the four following circumstances to be fully established in cases of Necrosis.

That the new bone is formed and consolidated before the old bone separates; that it surrounds the old bone, and is larger in size, but equal in length.

The facts ascertained by the above induction serve farther to explain the process which nature follows in the formation of the new osseous shell. The old
bone

bone serves as a mould for the new one. And the first step of the process is to surround the old bone with an effusion, which seems to be of gelatinous nature.

This effusion is more dense as it approaches to the surface of the old bone, and more rare as it recedes from it. The thickness of the stratum is variable, but it always is considerable, and in certain cases it appears to exceed an inch. For in some instances the new osseous shell has been found an inch thick, after the ossification is complete, so that the thickness of the original effusion must be greater than this, as the whole of the mass never is entirely converted into bone. And indeed before any bone begins to form, this effused stratum acquires an additional degree of consistence. After

these ossific nuclei make their appearance in different places, and quite distinct from each other, they increase in number, and enlarge in size, till at last they come into contact, and unite together, so that the whole of the effused stratum is converted into a mass of bone. The earliest date of the appearance of these nuclei in the human subject, is (so far as I know) twenty-four days from the original commencement of the attack. But for some months after a stratum of solid bone has been formed, additional nuclei are occasionally forming, attaching themselves to the ossified stratum, and thus making a gradual addition to the bulk of the general mass of bone.

The process proceeds in this manner, until the ossification extends completely
along

along the whole length of the original deposition, and around the whole of its circumference. The new bone which forms, is perfectly hard, and completely organized, but not disposed into the same regular lamellæ with the primitive bone. It is likewise capable of assuming all the actions competent to a bone of the most regular and perfect structure. If any part of it meets with an injury which deprives it of life, the dead portion then separates from the living, by the process of exfoliation*. It is also capable of giving birth to ossific granulations*, which are at last converted into solid bone. So that it appears to possess all the properties of a bone in the most perfect state of health and vigour.

From

* See Plate IV. with explanation.

From the account given of the manner in which this new bone forms, it is evident that the tendons of the muscles must retain their relative positions with respect to each other, and be inserted into points in the new bone, corresponding to their original insertions into the old bone. Because, at the time of the primary effusion, all the tendons lie in their natural and relative places ; and in this state they are surrounded and fixed by the gradual consolidation and ultimate conversion of the effusion into solid bone. And thus it is easy to comprehend the way in which the insertion of the muscles is transferred from the old bone to the new one.

The manner in which the tendons disengage themselves from the old bone, is
equally

equally easily conceived. The tendons are in a living and healthy state, and consequently incapable of continuing united with parts which are dead. They must necessarily, therefore, separate from the old bone, when it dies. And as they are previously attached to the nascent bone, no derangement results from the separation; which is effected without violence.

The dead portion of the old bone, which separates from the living portions, is distinguished by the appropriated name of *Sequestra*, and is a part which makes a conspicuous figure in the future management of the case.

SECTION II.*Origin of the New Parts.*

AFTER explaining the history of a case of Necrosis, we are naturally led to enquire into the origin of this new osseous shell, and into the circumstances which occasion its formation.

The origin of this new osseous shell was first, and indeed has generally been imputed to the enlargement and ossification of the periosteum of the old bone. This conjecture was easily grafted upon Mr Du HAMEL's opinion, that all bones were originally produced, and owed their growth to the surrounding periosteum.

How

How far Mr Du HAMEL's opinion is well founded, and, in what particulars it fails, it is not now necessary to enquire: But upon this foundation the growth of the osseous shell has been imputed solely to the extension of the periosteum, and to the deposition of osseous particles in the heart of its substance, or between its layers.

According to this latter supposition, that the bony matter is deposited between the layers of the periosteum, the new osseous shell should derive a complete covering from the original periosteum, both on its inner and its outer surface. That this, however, is not the fact, appears from an examination of parts while they are forming. It is then evident that ossific granulations arise both from

from the internal and external surface of the new osseous shell, but on neither of the surfaces does the smallest vestige of a covering derived from the original periosteum make its appearance. Indeed, this idea seems to me wholly incompatible with the inequalities of both surfaces. For, if two layers of periosteum were distended by the interposition of ossific matter between them, both surfaces would then be smooth along the whole of their extent. Yet, that the direct contrary takes place, is apparent from the slightest examination of appearances. Besides, in those cases, where the sequestra is removed, and consequently does not limit the extension of the new bone internally, the whole space fills up, and the cavity is totally obliterated along with the supposed investing periosteum. Yet, surely, this obliteration

tion could not possibly happen, if the internal surface of the new bone were fortified with a lining from the original periosteum.

And further, in all cases of Necrosis, the new bone in its incipient state is on its outside so blended with the neighbouring parts, that it is impossible to distinguish and separate them from each other; whereas if the new bone still remained encompassed on its outside with the external layer of the original periosteum, the separation of parts would be distinct and easy. Indeed, the want of this distinctness is almost of itself a proof that no covering is derived from the original periosteum. Besides, the supposed swelling and subsequent ossification of the periosteum has never yet been established by any regular series of accurate observations.

observations. And even according to this objectionable explanation of appearances, the process by which the new bone is generated and formed is wholly different from the ordinary process of ossification. The formation, then, of this new bone is at least an extraordinary effort of nature, to repair an accidental loss. And whether the reparation be accomplished by the periosteum, or by any other set of parts, the process is equally removed from the usual operations of the animal œconomy. To me, however, it seems proved almost to a demonstration, that the original periosteum has no share whatever in the formation of the new bone. I found my opinion upon the following considerations :

This

This new shell forms under circumstances where it is impossible that the original periosteum can have any share in promoting the process. There are certain cases of compound fracture*, in which the cure is accomplished by the formation of an osseous shell, exactly similar in all respects to the osseous shells which form in the common cases of Necrosis.

It is undoubtedly formed upon the same principles, and serves to unite the living extremities together, independently of any connection with the intermediate fractured portion. The case admits

B

of

* See Plate VI. with explanation. It is particularly necessary to consult the plate, since, without it, the description will not be so easily followed.

of some varieties, but all of them are equally repugnant to the supposition of the periosteum being instrumental in producing the new growth of bone.

In the one case the ends of the broken bone overlap each other, and from the manner in which they are entangled, it is impossible to disengage them; so that they must remain in this position during all the time of the cure. Yet even then the whole of the fractured portion is included in an osseous shell, although it be evident that in some part of the space at least, the periosteum of the old bone, can have no share in forming it*. Because at the place where the extremities overlap, one end of the bone on one side, and

* This will be better understood by consulting Plate VI. with the explanation.

and the other portion on the other, must be distant from the shell, equal to its diameter. The portion of the osseous shell, therefore, which forms over this vacant space, cannot possibly derive its origin from any connection with the periosteum. And indeed, in such cases, a stratum of the ossific effusion, which connects the living extremities, is in general deposited at a considerable distance from the intermediate portion which is fractured, and overlaps. So that, in this case at least, no one can entertain a doubt that the new osseous shell forms quite independently of the periosteum.

In the other case, the extremities of the bones do not indeed overlap, and the limb may be extended to its natural length, and placed in any position which

the surgeon chooses. But this great mobility proceeds from the violence of the injury which the bone has sustained. For, in very severe cases, the fractured portion is shattered into a number of fragments, which have no connection either with one another, or with the unbroken portions. In these fragments too the periosteum is completely torn and separated from the entire bone; so that it could not possibly have been useful in forming a continuous shell, even supposing it to have continued alive. While the probability is, that from want of connection with living parts, its own life, and the life of the fragments to which it belongs, will be totally destroyed. Thus, so far from contributing to the formation of new parts, which had no existence before, this insulated periosteum will

will not even be able to preserve its own place in the system. In such cases, therefore, it seems quite preposterous to ascribe any share in the production of the new osseous shell, to the action of a detached, and probably a lifeless portion of periosteum.

There is still another case in point, similar to the last, though seemingly more conclusive. In the case alluded to, a considerable portion of bone, along with its proper periosteum, is torn away by violence. Consequently a vacuity is left. Yet even this vacuity becomes completely filled up with osseous matter, independently of the periosteum which had been torn away. I have known a case in which a large portion of the angle of the lower jaw was broken off by the

kick of a horse's foot, and the loss supplied by a new growth. The patient, a bridegroom, was able to fulfil his marriage engagements a few months after the accident. And the periosteum having originally been torn away, could not possibly have any share in reproducing the bone. Though no one can believe that this instance of reproduction was not accomplished on the common principle of a Necrosis.

A confirmation of the same doctrine may be found in one very singular case of simple fracture. The cure proceeded without any difficulty or any apparent singularity, only that immediately over the place of the fracture there was an uncommon thickness of parts. This thickness, however, occasioned no pain nor inconvenience,

inconvenience. But upon examining the parts by dissection, it then appeared after how curious a manner the union of the fracture had been accomplished. For, contrary to the ordinary course of things, the extremities of the bones were not in contact, and the space between them was empty, but the connection was completed by means of an osseous ring, which extended from the circumference of the one to the circumference of the other, and bound them firmly together. This ring, it is evident, could not originate from the periosteum, since there was no periosteum at the place where it formed. But the truth is, that it originated in the same manner, and the case in every respect corresponded with those cases of compound fracture in which the cure is conducted upon the principle of a Ne-

crofis. The instance referred to happened in the person of a child, and the interval between the ends of the bone, was an eight of an inch.

An opportunity likewise occurred to me of observing the progress of a case in which, notwithstanding the total destruction of the original bone and its periosteum, a new bone formed in their place *. The patient was a middle aged man, who suffered an attack of paronychia in the middle phalanx of the ring finger.

* Mr James Clark, Fellow of the Royal College of Surgeons, an intelligent and attentive practitioner, favoured me with an opportunity of examining this curious and instructive case. And as the patient put himself under Mr Clark's care from the commencement of the complaint, I can implicitly rely on the accuracy of every circumstance.

finger. In the course of the cure, the whole bone and periosteum were taken away, and the finger was afterwards kept extended upon a small splint. After this the cure proceeded without any interruption, and was at last completed by the formation of a mass of bony matter which extended from the first to the third phalanx, and united them firmly together in one continuous bone. No new articulations were formed, so that this bone remained quite rigid, and consequently the finger inflexible. It was of the same length with the corresponding finger of the other hand; but considerably thicker at the middle part, which was composed of the new growth of bone. The destruction of the periosteum by disease, was in this case more obvious than usual, from the exposure

exposure of the whole parts to view, though I am persuaded that the same change takes place in consequence of the violent inflammation which accompanies every attack of Necrosis.

The whole of this doctrine derives additional confirmation from the result of some experiments which were made upon animals, for the express purpose of ascertaining this fact. In one experiment, the periosteum was scraped off from the bone of the leg, yet notwithstanding its removal, a new osseous mass was formed, with all the appearances which usually attend the renovation of bone, and in all the perfection of an ordinary case of Necrosis. This fact alone is conclusive on the point. And when it is brought in addition to the number of facts which
have

have already been adduced upon the subject, it is impossible to entertain a doubt of the inefficiency of the periosteum in the formation of the new bone, and that indeed the presence of the periosteum does in no case seem necessary to its production.

Thus, from a due consideration of every circumstance, it appears that the pulpy mass which extends from one portion of the bone to the other, and is itself at last converted into bone, is entirely a new creation, and has no dependence upon the original bone, or its periosteum. Yet, from whatever part it derives its origin, it serves the purpose of a bed for the ossific granulations to shoot from. There is no necessity that it should originally have any connection with the bone

bone or its membranes, since parts of a nature wholly different from bone are known to ossify in a great variety of morbid cases. Of this nature are the tendons, which very frequently are converted into bone. The blood-vessels also, especially the arteries, often suffer from ossification. It is likewise a well known fact, that small hard bony concretions are sometimes found in the heart of cancerous tumours. I have a specimen of this kind, in which a large portion of the cancerous tumour was converted into solid bone. Even the fat, of all parts of the body the most dissimilar to the nature of bone, is capable of being ossified. I have in my possession a portion of a common steatomatous tumour, in the centre of which there is a very complete and distinct ossification, about the
size

size of an ordinary pea. Thus, almost every part of the body seems capable of being converted into bone, by the operation of disease. So that the formation of bone in parts which originally were quite of a different nature, is not so extraordinary a fact in the human body. And as every consideration leads one to conclude, that the formation of the osseous shell, in cases of Necrosis, is independent of the periosteum, it is fortunate that nature possesses the power of replacing the sequestra, by means of a process not altogether so foreign to the actions of the system.

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SECTION III.*Causes which occasion the Formation of
New Parts.*

THE next question to be considered is, What circumstances in the state of parts give occasion to the formation of this new osseous shell; and whether it be in the power of art to insure the establishment of so salutary a process, whenever it would be advantageous for the patient? One circumstance is obvious, and constantly precedes or accompanies the formation of the new bone. Inflammation, more or less violent, attacks all the parts which are to be the seat of the new bone, previously to every instance of renovation.

tion. And it has been thought, that the death of the primitive bone must necessarily precede the commencement of any process to supply the loss of it. Some symptoms, indeed, which appear in the course of the disease, very much countenance this opinion. Since some time or other, in the progress of every case of Necrosis, a portion of the primitive bone seems to be entirely deprived of life, and to detach itself from the system; it was therefore very natural to suppose, that the death of the primitive bone must necessarily precede the commencement of any process for the reparation of the loss. This idea too, derived strong confirmation from the result of some curious and interesting experiments which Mr TROYA instituted, in order to ascertain the truth of the fact. By introducing a sharp instrument

strument into the medullary canal, and destroying the whole of the marrow, he contrived to deprive the bone of its life, without injuring the external periosteum, or the surrounding soft parts. And the result of the experiment was, that whenever the animal survived the severity of the operation, an entirely new osseous shell formed round the whole of the bone which was dead. Thus, he produced a number of artificial instances of the disease in question. In all of the experiments, the first step was to kill the original bone, so that the death of it, and the destruction of the marrow, necessarily preceded the commencement of any other process. And since these cases of natural and of artificial Necrosis were exactly similar in their ultimate state, the exactness of their final similarity naturally

naturally led to the conclusion that they agreed perfectly in all other respects, and arose from the same causes.

This opinion too, was the more probable, as in most cases of natural Necrosis, the sequestra is found dead, and the whole of its marrow gone. In the advanced stages of the complaint, the fact is constantly so. And as no circumstances of disagreement appeared in the cases under review, and as the destruction of the marrow and death of the original bone never failed to give birth to the formation of a new bone, the conclusion in favour of the similarity of the cases in other respects was not altogether unjustifiable. The death of the bone and destruction of the marrow is doubtless one never failing cause of Necrosis. But

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it does not thence follow, that no other train of circumstances are capable of producing similar effects. Indeed, I much question whether the death of the bone and destruction of the marrow be the sole cause of Necrosis, and always necessary to its production. Several considerations induce me to doubt the truth of the doctrine. It is a well known fact, that the moment any part of the body is wholly deprived of life, it separates from the contiguous living parts ; and in most cases, the time requisite to complete the separation is not great. In a case of Necrosis, therefore, if the old bone must necessarily be dead before the formation of the new one commences, it would be impossible for the patient to preserve the power of walking, during the whole of the time he was under the pressure of the disease ;

disease; because the sequestra, so soon as it was dead, would begin to separate from the old bone, and would completely leave its place, before any provision was made to repair the loss by the formation of a substitute. Thus, the limb would be deprived of all support from the old bone, without acquiring any stability from the substitution of a new one. So that in every case an interval must intervene between the separation of the sequestra and the consolidation of the substitute, during which the power of walking would be completely suspended. Accordingly, when the sequestra comes away prematurely, and while the rudiments of the substitute is still in a soft state, the limb is flexible and useless from the softness of the new bone, and requires the assistance of some rigid exter-

nal support to retain it in a straight position, and prevent it from bending. A like suspension of the power of motion, and a temporary flexibility of the limb, would also occur in every case of Necrosis, unless the new bone was fully consolidated previously to the final separation of the sequestra, and consequently unless it had begun to form before the sequestra was completely dead. It therefore seems probable, that the incipient formation of the substitute is prior to the death of the sequestra, and may originate from other causes. In proof of this opinion, we meet with instances of Necrosis, in which the marrow of the sequestra was entire and healthy at the time of its separation, many months after the commencement of the attack, and even posterior to the consolidation of the substitute.

tute. I likewise possess a preparation of an incipient case of Necrosis, which illustrates this point in the clearest possible manner*. In this preparation one plainly perceives the sequestra in the act of separating from the extremities of the bone which are to remain, and that it still preserves its life, and is full of blood-vessels; and these blood-vessels have a direct communication with the arterial trunks which supply the rest of the limb, since a quantity of injection readily passed into the substance of the sequestra, and pervaded every part of it. In those appearances there is no indication even of approaching death in that portion of bone which is destined to become the sequestra, and which soon would have separated from the rest.

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Then

* See Plate III. with explanation.

Then as to the state of parts which surround the sequestra, and which ultimately were to ossify and supply its place, there is a stratum of ossific matter extending along the course of the sequestra, including it, and connecting the permanent extremities of the bone together. This stratum, which is of considerable thickness, is the bed of future ossifications, and in one place an ossific nucleus had begun to form, and may be distinctly seen. And from the rapid progress of its formation, it seems probable that the ossification of the substitute would have been complete, or at least far advanced before the death and separation of the sequestra. Independently, too, of what the probable consequences would have been, if the progress of the cure had not been stopped by the amputation of the limb,

limb, the actual state of parts presented to view, affords the clearest evidence that the substitute bone begins to form long before the original one dies. To consider then the previous death of the sequestra, as the only exciting cause of Necrosis, is to adopt far too limited a view of the subject; for both the cases which I have described, tend to prove, that the substitute bone may be far advanced in its formation before the sequestra dies, and the marrow be destroyed. It therefore appears certain, that the previous death of the sequestra is not indispensable to the production of the incipient states of Necrosis.

Indeed the truth seems to be, that no evident symptom invariably precedes the natural Necrosis of a bone, excepting an

attack of inflammation. But inflammation constantly precedes the formation of new parts. And the probability is, that the effects of the inflammatory attack have a double operation, and are the source, both of the death of the old bone, and of that state of action, which gives birth to the generation of the substitute. The foundation of both processes, the one terminating in death, and the other in reproduction, would therefore seem to be laid at the same time, and to depend upon one common cause. They are contemporary in their commencement; and the formation of the substitute bone is the offspring of the same attack of inflammation, which kills the sequestra, and not the consequence of its death. In that case of paronychia, too, in which the bone and its periosteum were completely

pletely removed from the finger, a perfect substitute bone was formed, although the commencement of the reproduction was posterior to the removal of the original parts, so that the presence of a dead sequestra could not possibly have a share in promoting it.

In this instance, at least, the exciting cause of the reproduction must have been very different from any stimulus which it was in the power of the original parts to communicate.

Upon the whole, then, this conclusion is manifest, that although the death of a bone, from the destruction of the marrow, may be one cause of producing an attack of Necrosis ; yet, that this circumstance

cumstance alone is not the sole and indispensable cause of its production.

Inflammation always precedes Necrosis; and many different causes excite that kind of inflammation, which terminates in Necrosis. For it is not every attack of inflammation, but only those of a peculiar or specific nature, which have this termination. But as yet we are not acquainted with that peculiar stimulus, which, in the human body, has the power to excite such an attack of inflammation, as will ultimately terminate in a case of artificial Necrosis. All such cases have hitherto been the creature of accident, arising at times when they were little expected, and owing no part of their origin to the interference of art. It would doubtless be most convenient to possess the

the means of calling forth so useful an effort of nature, when there is no prospect of effecting a cure, unless some extraordinary exertion takes place. But as yet this is an expectation, which we cannot indulge with confidence, and must at present content ourselves with the power of managing the cases which naturally occur, in a manner the most advantageous to the patient.

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SECTION IV.*Particular History of Symptoms.*

IN every case of Necrosis, a severe deep seated pain is the first symptom which appears.

This pain, at its commencement, is not aggravated by pressure. But as the inflammation travels outwards, and acquires a more superficial situation, the external parts become more sensible, till at last they acquire the sensibility of parts in a state of high inflammation. Such is the progress of the pain.

At

At the outset of the attack, no other symptom makes its appearance. Neither the size nor the shape of the limb undergoes any sensible change for some time. But so soon as a stratum of materials is laid for the deposition of osseous matter, the limb becomes much enlarged along the whole course of the bone; and this enlargement occurs at an early period of the complaint, and soon attains its full size. Afterwards it continues stationary and unchangeable, both in size and shape. In the leg, which is a common seat of Necrosis, this enlargement may be distinctly traced by an external examination of the parts. It follows the course of the tibia, a bone in which Necrosis often occurs. Thus an incipient case of Necrosis is characterised by a deep seated excruciating pain, not at first

first aggravated by pressure, and which is soon followed by the rapid enlargement of the parts along the course of the bone. The degree of pain indeed is variable. Though whenever we find a deep seated pain accompanied with a sudden enlargement of the parts along the course of the bone, we have reason to suspect the presence of an incipient case of Necrosis.

These symptoms, however, do not long remain stationary; but sooner or later acquire an addition to their number. For, shortly after the commencement of the attack, an external inflammation succeeds, and this is soon followed by suppuration and a collection of matter, which at last discharges itself externally by a small opening. The extent

of this inflammation is not in general great. Though for the most part a number of similar circumscribed inflammations make their appearance about the same time. They all of them discharge matter externally through small openings which do not close, and by continuing open, and discharging matter, prove the origin of a number of fistulous sores. In general, the fistulas which form in this way, lie in the most projecting line of the bone. In the leg, they are all situated on the anterior part where the bones are most thinly covered with soft parts.

These ulcers are seldom provided with an extensive surface *. The orifice is in general surrounded by a small prominence, somewhat elevated above the level

* See Plate V. with explanation.

vel of the skin. The elevation of the prominence is commonly a quarter of an inch, and its diameter half an inch.

The matter which discharges from these fistulæ is almost uniformly of a good quality, neither offending in point of smell, colour, nor consistence. In these respects it differs from the quality of the matter discharged from a diseased bone, which is at all times exceedingly foetid, and in general discoloured and thin.

In point of quantity, the discharge of purulent matter is always very great, in proportion to the number and size of the external openings. Because they are only the terminations of passages which conduct to an extensive cavity. And in
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this circumstance they perfectly agree with the common character of a narrow fistulous opening, that leads to a large internal collection of purulent matter. But, in other respects, the coincidence of symptoms is not so complete. For, in other cases of purulent collections about the extremities of the body, the application of external pressure increases the quantity of the discharge. In a case of Necrosis, however, it has no such effect; and the reason of the difference is plain. In a common abscess of the cellular substance, however deeply seated, the effect of external pressure is propagated through the soft parts, till it reaches the seat of the abscess, and expels the matter through the orifices. The soft nature of the parts admits of their yielding. But in a case of Necrosis, it is im-

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possible they can yield in the least; because the collection of matter is lodged within the cavity of the newly formed osseous shell, which is rigid and inflexible, and does not yield to pressure. It is obvious then that the cavity admits of no diminution, and consequently that the quantity of the discharge cannot increase by the application of pressure to the external parts of the limb. For the same reason, it is evident that the most delicate touch can perceive no sign of fluctuation, however obscure, by the external examination of the parts. The firm shell of bone which contains the matter, prevents any motion from being felt. The discharge proceeds altogether from the inside of the bone, which is the cause of the different appearances that take place.

Appearance

Appearance of the parts. The extremities of the fistulous openings are generally red, and well coloured on their surface; and though they continue long stationary, and show little disposition to heal, they rarely exhibit an unhealthy appearance, or become what is termed ill conditioned ulcers.

A probe introduced at the orifice of the fistula, seldom penetrates to any great depth, or discovers any loose piece of bone. For, in this stage the sequestra can very seldom be felt. Sometimes, indeed, small spiculæ of bone pass through the external openings, along with the purulent matter. Their appearance, however, is not constant; but whenever it happens, we are certain that the bone is at bottom concerned in sup-

porting the disease. These separating spiculæ too are rarely felt loose and moveable any time before their final ejection. They appear unexpectedly, without giving any previous intimation of their approach. The reason of which is, that they do not separate from the external surface of the bone, but are portions of the sequestra which is included within the cavity of the new osseous shell, and consequently protected from the touch of the probe at the time of their separation. No doubt some other deep seated exfoliations may exhibit somewhat of a similar appearance; but, excepting in a case of Necrosis, no such appearance can occur, when the bone lies superficially.

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The number of these ulcerations will be more or less great, and the discharge of matter more or less profuse, and of longer or shorter duration, according to different circumstances. But, in all cases of Necrosis, they make their appearance at some period or other of the complaint*.

Even the preparation of the bones of those cases of Necrosis whose history is not known, show plainly that such fistulous openings must have existed during the pendency of the disease. It is indeed possible to conceive a case so mild in its symptoms, that it shall complete the substitution, without producing any ulceration externally; though, as yet, no

D 3 instance

* See Plate I.

instance of so mild a case has ever occurred in practice.

The progress of all cases of Necrosis is nearly alike, till the appearance of these ulcerations. The symptoms may indeed be more or less violent, but in other respects they are similar. But, after this period, the appearances differ very much, according to the manner in which the case is to terminate. There are two very distinct terminations.

In the one, the mildest and most desirable termination, the ulcerations gradually heal up, without exhibiting any unusual appearance. The sequestra never is seen; and the patient, if he ever had lost the use of his limb, soon regains it, and is again enabled to walk with ease

ease and firmness. After this, no vestige of the disease remains, excepting a permanent enlargement and induration along the course of the bone. So that no very singular symptom appears in the course of this termination.

In the other termination, which is less favourable, but attended with more curious and interesting symptoms, the sequestra makes a conspicuous figure. It appears externally, by forcing a passage for itself through the new formed bone, and the common integuments. Sometimes it works its way out, without being preceded by any considerable suppuration or collection of matter. In this form of attack, the degree both of pain and inflammation is very moderate, and the bone often projects suddenly and un-

expectedly, to the great surprize of the patient, but without giving him much uneasiness. The case, however, is different, when the protrusion of the bone is preceded by any considerable suppuration and collection of matter ; for then the pain which the patient suffers, is often very great, and does not abate till after a natural or artificial opening of the abscess has removed the tension and irritation.

The extremity of the sequestra, at the time of its protrusion, is always rough, and in general exceedingly irregular and sharp. It may be moved by shaking, but is too firmly wedged in with the neighbouring parts, to allow of its complete extraction. In time, however, this firmness diminishes, and the sequestra

questra gradually becomes looser, partly in consequence of the consumption of a portion of its own substance, and partly from the wasting of the new formed osseous shell, by pressure *. At last, however, from the conjoint operation of these two causes, the passage in general becomes wide enough to permit all that remains of the sequestra to escape.

In other cases of Necrosis, however, it is not the extremity of the sequestra, but a part of the middle portion, which presents itself upon the opening of the abscess †. The new shell of bone incloses the sequestra on every other side, and though it permits of motion upwards and downwards, in the direction of the cavity

* See Plate V. fig. 2, 3.

† See Plate V. fig. 1.

city of the bone, yet it confines the sequestra too closely to permit of any lateral motion: Under these circumstances, the process for the ejection of the sequestra may go on very slowly, and unless some material change takes place in the position or destruction of the parts, they may remain unchanged for a great length of time. It is indeed difficult to say what would be the final result of such a case, if it were permitted to follow its own course; since the assistance of an operation is so highly necessary to complete the process, that the conclusion of the case is never left to the spontaneous efforts of nature. The interference of art being indispensable to complete, or at least to accelerate the cure. Thus the natural termination of this form of an attack of Necrosis, is still somewhat a matter of conjecture.

It is evident that, upon the final ejection of the sequestra, the cavity of the new bone must be left empty, and free from every kind of irritation which the presence of an extraneous body might produce. So that there is not in future any impediment to retard or interrupt the progress of the cure.

But before entering upon the discussion of this point, it will be necessary to recur to the consideration of the state of the internal cavity of the new osseous shell when the cure takes place, without the exclusion of the sequestra. It is obvious, that the newly formed cavity must either be full or empty; and experience shows, that both conditions obtain. According, indeed, to the general account
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of Necrosis, given at the beginning of this paper, the sequestra was supposed always to remain included within the cavity of the new shell, because this supposition afforded the simplest view of the disease. The complete inclusion of the sequestra, however, is not perhaps the most frequent case ; for in the plurality of cases, the whole of it is either dissolved or ejected, and in both events the cavity of the new bone is left wholly empty. So far then these two cases are similar in their circumstances, and they likewise are similar in the process which they afterwards follow to dispose of this cavity. For in all those cases in which the sequestra is removed, either by dissolution or ejection, the cavity of the new bone fills completely up, so that no regular

gular vacuity remains at the end of the cure *.

The cases in which the sequestra is completely ejected, afford us an opportunity to observe the process by which the cavity is filled up, as all the parts concerned in the process lie open to inspection, while the necessary changes are going on. In the other case, in which the sequestra never makes its appearance, the process indeed is not visible during its pendency ; but as the cases are in all other respects perfectly similar, there can be no doubt that the cure is conducted upon the same principles, and completed in the same manner.

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* See Plate IV.

In the early stages of Necrosis, the internal surface of the new osseous shell is capable of sending out granulations from every part of the surface. These granulations rise in all directions, and grow with great rapidity. As the prominence of these granulations increases, the size of the cavity gradually diminishes. At last they meet about the centre, unite together, and form one solid mass, which obliterates the cavity for ever. After this the surface of the fore cicatrises before the granulations have time to be converted into bone. The conversion, however, commences at an earlier period of the disease, among the first sprung granulations. These begin to ossify before the last grown are completely covered over with skin. It may be proper to observe, that this description is taken from

from the case in which the ejection of the sequestra or removal of the anterior portion of the new shell leaves all the process in view. Thus it appears in both cases of the removal of the sequestra, whether by absorption or ejection, that the substitute bone becomes solid in place of hollow.

These various terminations of Necrosis are determined by the circumstances of the case, and present a number of curious appearances in the course of the attack. The ejection of the sequestra, for instance, may obtain either before the osseous shell is completely formed, or after it is fully consolidated. In the first case, the patient will suffer a temporary suspension of the use of his limb, because the separation of the sequestra takes place

place while the new bone is in a soft state, and unable to bear any weight. In the other case, the patient is perfectly able to use his limb during all the time of the cure, because the consolidation of the new bone is sufficiently advanced to support every exertion it is exposed to before the sequestra leaves its place. The relation which the consolidation of the new bone bears to the separation of the sequestra, produces these varieties.

The slow ejection of the sequestra indicates a moderate attack of inflammation. But when the sequestra separates more quickly, and while the new bone is in a soft state, the separation is always the consequence of severe inflammation, and is accompanied with very violent symptoms,

symptoms, and with the temporary suspension of the motion of the limb. This premature separation of the sequestra occurs more frequently in the Necrosis of the lower jaw. The chin is then deprived of its natural and proper support, and falls down upon the neck, exhibiting a very strange and uncouth appearance.

The sequestra too, without coming away altogether, sometimes separates from the old bone at both its extremities, in some more early period of the disease. The limb then has the appearance of having given way at two different places, in the manner of a fracture, and the patient is unable to use it for some time after this separation or supposed fracture has taken place.

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Such are the various appearances which cases of Necrosis exhibit, when the sequestra is separating from its new covering of bone.

In the other form of the attack, where the sequestra is removed by dissolution and absorption, without making its appearance externally, the disease is more uniform in its progress, and does not admit of so great a variety of symptoms. The process is necessarily tedious, and always attended with a profuse discharge of matter. But besides the general enlargement of the bone, this is the only striking circumstance which takes place. The quantity of matter first gradually increases, and then gradually decreases, till at last it ceases altogether. These constitute the only visible symptoms in
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this form of Necrosis. For the changes which the sequestra undergoes are concealed from sight, and are only inferred from collateral circumstances.

The dissolution of the sequestra is more or less complete. In young subjects it is more quickly and more completely dissolved. In those of more mature age, the dissolution of it is more tedious and uncertain. And in some cases a small portion remains unchanged, and resists all the power of the system.

As to the causes which effect the destruction of the sequestra, it is plain, that only a small proportion of it can be destroyed, while it remains in its natural place, united at both extremities with the permanent portions of the ori-

ginal bone, and that after its separation, it is removed from the ordinary sphere of action of the living parts of the system; so that it must then decay from some other cause. The internal and softer parts disappear first, and probably owe their decay to the spontaneous decomposition which all parts of the body naturally undergo, when they are deprived of life, and detached from the system. The gradual operation of these unseen causes is perhaps sufficient to accomplish the destruction of the sequestra in most cases. At the same time, their action is doubtless very much promoted, and the process of dissolution very greatly accelerated by the solvent power of the purulent matter which surrounds the sequestra. For this constant maceration facilitates the spontaneous decomposition of the

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the detached bone, and by reducing it to a fluid state, prepares it to be removed by absorption, or to be washed out along with the discharging of matter.

It has already been observed, that the most severe cases of Necrosis are those in which the sequestra forces its way through the osseous shell with great rapidity, and with violent inflammation and supuration; and that, on the contrary, those are mildest, in which the sequestra never makes its appearance externally. The latter case admits of two varieties, opposite in their nature; one, in which the sequestra is wholly consumed or removed; another, in which it continues nearly with its original size unimpaired. This last case is the mildest of the two. And

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the cause of its superior mildness is sufficiently obvious. It proceeds from the lesser degree of irritation which the contact of the sequestra excites upon the ossific granulations of the osseous shell; so that in a short time the sequestra ceases to act as a stimulus, and allows the granulations to ossify and consolidate. In some cases the irritation is so inconsiderable, as to give the patient very little uneasiness or distress.

It is somewhat singular, that the two mildest cases of Necrosis are so contrary to each other, that in the one the sequestra is entirely consumed, in the other that it remains almost entire. The intermediate states are by much the most severe. And when no circumstances determine the sequestra to burst from its confinement,

confinement, and there is too much irritation to allow the parts to remain unmolested, and too little to produce a total consumption of the sequestra, the case seems to have no natural termination. It forms what be termed a chronic case of Necrosis, and may continue to harass the patient for an indefinite length of time. The degree of suffering will be greater or less, according to circumstances, but will always be sufficient to tease the patient incessantly, and to disturb the tranquillity of health.

In the Necrosis of the long bones, the osseous shell which contains the sequestra is always perforated with a number of holes, placed irregularly at unequal distances*. These holes correspond to

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* See Plate I.

the external fistulous fores, and are the openings through which the matter found a passage from the internal surface of the shell. They are commonly of a circular form, with smooth rounded edges. They remain in the osseous shell, without ever filling up when the cure obtains by the preservation of the sequestra. But when the sequestra is totally destroyed, and the whole cavity of the shell filled up with osseous matter, the apertures of these holes likewise fill up; and after the cure is complete, nothing but a vestige of them remains on the surface of the substitute bone.

Such then is the progress which in a very great number of cases I have observed Necrosis to follow: And, in general, the changes which take place, admit

mit of an obvious and satisfactory explanation. In a few singular cases, indeed, the cause of certain appearances is not so obvious. When, for instance, a bone separates at its articulation with another bone, and from the perfect state of the articulating processes we have proof that no part of the original bone is left in the socket, there may be some difficulty to conceive the means which are employed to preserve or renew the motion of the joint. The possibility of the case, however, appears from the examination of many cases of indisputable accuracy and authenticity. I have in my possession, a portion of the lower jaw, which separated from the rest, in a case of Necrosis *. The whole condyloid process is smooth and entire, and nothing but the

* See Plate V. fig. 4.

the covering of cartilage is wanting to make this part of the articulation complete; yet the patient was in some measure able to move his jaw, both while the sequestra was separating, and after its final separation. The motion of the jaw, however, was very limited during the time of the separation, and there was considerable swelling over the region of joint. This swelling might help to retain the parts nearly in their natural places, and to regulate their motion; but the regular motion of the jaw was probably performed by the condyle of the opposite and sound side, which had not suffered from the effects of disease. It is plain, that the new production of bone could not possibly occupy the articulating cavity of the temporal bone, so long as the original condyle remained in
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its place. But after the separation and removal of the original condyle, the ossific granulations would have an opportunity to extend themselves towards the articulating cavity, adapt themselves to its shape, become attached to the cartilage, and thus serve all the purposes of the primitive condyle. In this way, the process which completes the redintegration of the joint is easily understood. I never, indeed, had an opportunity to see above one condyle come away from the jaw of the same person. I knew, however, that instances are reported of both condyles separating at the same time, and that the credibility of the assertion rests upon the testimony of very unexceptionable reporters. For my own part, I believe in the truth of the fact, and think that the circumstances of the case admit

admit of being explained. It is certain, that at one period of the process, the jaw is almost closely shut, and next to immovable, in consequence of the symptomatic swelling which retains all the parts nearly in their natural places. This state continues till the separation of the sequestra removes one impediment to motion. Its separation, however, does not at once restore the power of motion, though it permits the ossific granulations of the new bone to occupy the empty articulating cavity, and pave the way for the formation of a new joint. After this foundation is laid, and the new granulations have formed adhesions with the articulating cartilage of the former condyle, the motions begin to be made more freely, and to be regulated more accurately. The surrounding mass of new bone

bone gradually wastes away, so that the shape and size of the parts at last adapt themselves to their new situation. And thus the subsequent motion of the jaws removes any incumbrances which arise from the superfluities of the new growth. In these cases, however, the proper articulating surface never is destroyed; for the cartilage which belongs to the original bone still remains in its place, and the capsular ligament is nowhere injured or opened. I never have known an instance in which the articular cartilage came away in a case of Necrosis. It seems, however, to undergo a change, in order to accommodate itself to the enlargement which takes place at the head of the new bone; for that piece of cartilage, which tips the head of the new bone, is always considerably broader than the

the surface of the original cartilage, and consequently must have increased in size, in proportion to the greater extent which it had to cover. In this way those changes are accomplished, which enable the substitute to supply the place of the original bone, in performing the motions of a joint.

The foregoing description accords most accurately with Necrosis of the long bones, though the same principle pervades the Necrosis of every other class of bones, and is accomplished in the same manner, making allowance for the variations which the difference of shape and other circumstances may render necessary. Thus, in the lower jaw, the difference of shape and of position, and of structure, produces some peculiarities
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in the appearances of a case of Necrosis. The most remarkable of these is the power of retaining the teeth on certain occasions, and even of forming new sockets to hold them. In this termination of the case, the patient suffers little inconvenience, as the substitute bone acquires sufficient firmness to give support to the teeth, and serve all the purposes of mastication. It is obvious, however, that the preservation of the teeth cannot be a frequent occurrence, as there is no possibility of it taking place, excepting in those cases in which the old jaw comes away downward, through a wound in the skin. For whenever the jaw separates upwards, and is drawn into the cavity of the mouth, the teeth must necessarily come along with it; and from many

many circumstances, this is the direction which will in general prevail.

In the first place, the coverings of the jaw are much thinner towards the side of the mouth, and sooner and more easily destroyed by disease, consequently the jaw is oftener uncovered at the upper part, so that the separation and detachment more frequently begins there.

Besides, the death and separation of the jaw frequently arises from some disease in the teeth or gums, which, from their situation, naturally determine the complaint to begin at the upper part, and to proceed downwards. All these circumstances operate even in a healthy state of the parts; and in cases where a new bone is forming, the determination

to push the old bone upwards is still more powerful. Because in the formation of a new bone, the first step of the process is to accumulate a quantity of adventitious matter around every part of the jaw, excepting the upper part, into which the teeth are fixed. This deficiency must always exist. Therefore, in every case of Necrosis of the lower jaw, there will be a vacancy in the upper part, through which the sequestra may pass, so that in no instance can it be surrounded and included by the new bone. As the accumulation of adventitious matter very greatly increases the thickness of the surrounding parts, and soon acquires a considerable degree of firmness, the extraction of the jaw downwards becomes infinitely more difficult; and though it might be possible to ex-

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tract .

tract it in this direction, yet the opening through which it must pass, would necessarily leave a chasm in the bottom of the case of new bone, which would prove an inconvenience, in so far as it diminishes the solidity of the support. Considering all these circumstances then, it is questionable how far it is prudent to attempt the preservation of the teeth, at the expence of producing an extensive wound in the integuments, and a chasm in the bottom of the new bone. Besides, it is seldom in our power to save the whole of the teeth, from the circumstance of the vacillation and falling out of the teeth being one of the first symptoms which occurs. In those cases, indeed, in which any of the teeth are preserved, their preservation arises from the accident of some external fistulous opening

opening having previously been formed, which induces the Surgeon to examine the state of the parts from without, to enlarge the opening by an incision, and to extract the diseased loose bone downwards. Upon the removal of the sequestra, the teeth still continue adhering to the gums, which support them in their place. In this situation, the new bone forms round the teeth, and consolidating into a firm substance, keeps them as steady and immoveable as their original sockets.

It is farther to be observed, that the prolongation of the incision for a sufficient length, to permit the extraction of the whole, or even of a considerable portion of the jaw, endangers the division of the facial artery; and from the size

and situation of this artery, a hæmorrhage from it might be very troublesome to stop.

These are the chief circumstances which come into consideration, in determining the proper place for removing any part of the lower jaw, which is loose and moveable. But in whatever direction the jaw is to be removed, there are some consequences of its separation which merit particular attention. A very large nerve and artery run in the centre of the lower jaw for almost the whole of its length; and if the whole jaw were to come away in one entire piece, both the nerve and the artery must be completely destroyed. In general, however, the fact is, that a sufficient portion of the internal surface of the bone is destroyed
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by erosion, to permit the nerve and artery to pass without receiving any injury *. This is the termination of all the cases of Necrosis of the lower jaw, which I have had an opportunity to examine. In every one of them the cure succeeded happily, leaving the patient the free and complete use of his jaw.

These are the principal particularities which attend an attack of Necrosis on the lower jaw, and which I have collected together, and arranged under one head, in order that they might be more easily understood and remembered.

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* See Plate V. fig. 5.

SECTION V.

Seat of Necrosis.

THIS disease does not attack all the bones of the body promiscuously. It is the long bones which are chiefly liable to be attacked. Indeed, excepting the lower jaw, I know of none of the flat or irregularly shaped bones that ever become the subject of Necrosis. The bones of the cranium, of the face, the sternum, ribs, scapulæ, vertebræ, bones of the pelvis, and even bones of the carpus and tarsus, do not admit of reproduction by this process. As to the bones of the metacarpus and metatarsus and phalan-

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ges of the thumb, fingers and toes, they are at least very rarely the seat of Necrosis, and do not readily admit of a cure by reproduction, when they are attacked by any severe disease.

Of all the bones of the body the tibia undoubtedly is the most frequent subject of Necrosis; and next, perhaps, in point of frequency, the femur and lower jaw; and then the clavicle, humerus, fibula, radius and ulna. As to the patella, I know of no instance in which the loss of it has been supplied by a reproduction of new bone.

SECTION VI.

Duration of Necrosis.

The duration of a case of Necrosis is variable, depending both upon the age of the patient, and upon the circumstances of the particular bone which is attacked. The younger the patient is, however, the process is on every account more expeditious. The corresponding bones are of smaller size, of less firm consistence, and all the actions of life go on with more rapidity. It is indeed difficult to lay down any general rule for the time which an attack of Necrosis requires to complete its course, on account of

of the difference of time requisite in different bones. The lower jaw, so far as I have observed, is capable of completing the process in the shortest time. A cure may be completed in less than three months from the first moment of the attack. But I never have known a case of Necrosis of the tibia in the person of an adult, completed in less than twelve months. In general, it is a longer time, and sometimes nearly two years. This computation is to be taken from the first commencement of the attack of the pain, till the final termination of the cure, when all the ulcerations have dried up, and the new substitute bone has arrived at perfect consolidation. But, in particular instances, the cure is protracted to a much greater length of time. A case of Necrosis of the os femoris has been
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five or six years of completing its course ; and during all the time of its continuance, the patient was able to discharge the different duties of his station. For those very tedious cases are always very mild in their symptoms. Indeed it is impossible they could be otherwise, else no strength of constitution could withstand an attack of so long duration. Accordingly, we do not find the patient complain of distress, his health is not impaired, and he suffers no inconvenience which bears any proportion to the alarming appearance of the symptoms. For in all cases remarkable for the slowness of their progress, the sequestra protrudes externally, and is long of separating : So that the case exhibits the singular appearance of the bone projecting through the skin, without depriving the limb

limb of its support, and continues long in this state.

From this view of the subject, then, it appears, that Necrosis is a tedious, though not properly a chronic disease, and that the duration of a case admits of considerable latitude even in patients of the same age, and when the same bones are the subject of attack.

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SECTION VIII.*Of the Age of Patients subject to Necrosis.*

NECROSIS is properly a disease of the earlier periods of life. I have never known a case of it in which the attack began after the twentieth year, excepting in cases of Necrosis of the lower jaw. About the age of puberty, or from twelve to eighteen years of age, is the time of life at which patients are most liable to be attacked. I have indeed known of instances in which the patient was so young, as six and seven years of age, but never heard of a case in which the disease

case began at an earlier period of life. But if in all attacks upon the long bones, the patients are always in early years, in almost every case of Necrosis of the lower jaw, the patient is above thirty. In a few solitary instances, indeed, they are so young as ten or twelve, though this is but a rare occurrence. And to compensate the youth of a few, we may advert to the old age of others. For the most advanced periods of life are not exempted from an attack of it. One patient of eighty years of age is said to have lost the lower jaw by Necrosis; but it is not clear that the loss of the old jaw was supplied by the growth of a substitute. Yet in patients somewhat younger, though still very far advanced in years, a substitute has been formed to replace the loss,

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The state of the constitution has a great share in favouring an attack of Necrosis. When this disposition prevails, an individual will often suffer from attacks on different bones at the same time. I have known an attack upon the clavicle and tibia at one time. Sometimes it attacks both tibiæ. Sometimes both arms. Sometimes a leg and an arm. Upon the whole, however, it is more common that the different bones of the same individual suffer attacks at different times. And in general there is a considerable interval between the attacks. But while Necrosis of the long bones may be cotemporary in their commencement, it never happens that a Necrosis in one of them exists at the same time with a Necrosis of the lower jaw. And this surely is a very singular circumstance

stance in the human constitution; since we naturally should expect, that the same general disposition would prevail over all the bones of the body at the same time. On the contrary, however, experience shows, that in early life the long bones, and in the advance of years, the lower jaw are predisposed to suffer from Necrosis.

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SECTION IX.

Causes of Necrosis.

Of the causes of Necrosis, no very satisfactory account can be given. It seems, however, evidently to be connected with that state of the constitution which depends upon the age of the patient. I am likewise inclined to believe, that it more readily attacks those who have a scrophulous taint in their constitution. But farther than this I know of no circumstance which predisposes to an attack of Necrosis.

SECTION X.

Occasional Causes.

WHEN the constitution of the patient is otherwise predisposed to Necrosis, any occasional cause which is capable of exciting inflammation, may occasion an attack of it. In many cases, however, it is purely a sporadical disease, not referable to any external cause. There is no external hurt, no violence to produce the inflammation which ushers in the attack of Necrosis. And what seems remarkable, those cases of Necrosis which originate in some external injury, generally occur in the lower jaw. For this reason,

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cases

cases of Necrosis of the lower jaw may often be traced to the effects of blows, of toothach, especially if a violent attack of inflammation has been excited by the application of any acrid substance to a carious tooth, of salivation occasioned by mercury, of small-pox, of scurvy, of exposure to cold exciting pain, and the usual concomitant symptoms. At the same time, it must be acknowledged, that farther than these causes tend to excite general inflammation, there is nothing peculiar in their operation which contributes to favour an attack of this disorder.

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SECTION XI.

Diagnosis.

THERE are various morbid affections of the bones, with which a case of Necrosis may possibly be confounded; though, if due attention be paid to the discriminating circumstances, one is almost certain of avoiding a mistake. The cases which bear the nearest resemblance to Necrosis, are properly two in number. But another case is often brought in as a third.

The *first* is a general enlargement of a bone.

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The *second*, a case of common exfoliation of an external lamella.

And the *third*, what has been termed a case of internal exfoliation.

A general enlargement of a bone simply from its increase of osseous substance, is distinguished from a case of Necrosis by different symptoms. A simple increase of size is not necessarily or constantly attended with pain at the commencement of the disease. The date of its commencement is much more indeterminate, and its progress vastly more gradual and slow. The external soft parts are neither swelled nor inflamed, nor do they adhere to the bone beneath. And as the case is not attended with suppuration, there are no fistulous

lous ulcers to discharge matter. These are the chief circumstances of difference between the two cases.

The exfoliation of an external lamella of bone likewise admits of discrimination. It is indeed only in some cases, and in certain stages of those cases, that any resemblance obtains between the two diseases. The resemblance is greatest when the sequestra is ejected spontaneously, and is much decayed before it comes out. If the sequestra be less than half a cylinder, and be worn very thin, it will more nearly assume the appearance of a superficial exfoliation. But even in this state it is possible to mark some difference ; because a sequestra is generally much more ragged at its sides and extremities, which are provided with

more long sharp projecting points *. The sequestra is more frequently perforated with holes which penetrate through its whole thickness. Besides, there is less difference in the smoothness of the convex and concave surfaces. But in a case of common exfoliation, the difference between the degree of smoothness of the two surfaces is much more remarkable. The convex surface being in general evidently smoother than the concave. Such are the differences which respect the appearance of the bone after it is completely separated.

In the act of separation too, other discriminating circumstances may be noticed. The point of the bone is never directed so obliquely in a case of ordinary

* Plates II. and IV.

nary exfoliation; and the kind of motion which the loose portion admits of is very different. In a case of common exfoliation, the exfoliating portion may be depressed or elevated by the application or removal of external pressure, on account of the bed of granulations which support it beneath. But while the granulations permit the motions of elevation and depression, they prevent any lateral or longitudinal motion, by growing over the edges of the exfoliating lamella, and confining it on every side. A sequestra, on the contrary, even when no more than a small portion of the surface presents externally, admits of motion upwards and downwards in a longitudinal direction with great freedom, but cannot be depressed, because it rests not upon a

soft cushion of granulations, but upon a firm support of bone.

In a case of exfoliation too, the granulations are less firm, of greater extent, and allow a probe to be introduced between them and the surface of the bone. And as they arise from a diseased bone, they are often of exquisite sensibility, which is not the case in Necrosis, where the basis of the granulations is found.

The bone also feels rough, and in most cases of exfoliation, any irritation excites excruciating pain.

The attack of the disease is much more limited in its extent, and not accompanied with any general swelling of the limb. If the bone enlarges at all,
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it is only to a small distance above and below the ulcer, and then it is not surrounded by any swelling of the soft parts.

Next the discharge of matter. As to quality, it is in general fœtid and thin, and the quantity is not so great in proportion to the surface of the sore. The complexion of the ulcer is much more unfavourable, and it never is elevated above the level of the surrounding surface, in form of little papillæ. These are the symptoms which I should consider as affording the most characteristic distinctions between a case of Necrosis and of common exfoliation of an external lamella of bone.

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The last head, the distinction between a case of Necrosis and what is termed a case of internal exfoliation, must be treated entirely in a different manner, since it is not clear that such a case actually exists. So far, at least, as I have been able to investigate the subject, it appears to me that the account which authors have given of this form of the attack is altogether erroneous. For any cases of it, the histories of which are related in detail, seem plainly to be cases of Necrosis, so strongly characterised in their leading symptoms, that it is a matter of surprise, to find that any other view of the disease had been suggested. Without entering farther into particulars, it is pointedly mentioned, that the new shell of bone was in some cases half an inch, and in other a whole inch thick, and that the exfoliation was quite

quite moveable under this arch. Now, both circumstances coincide with symptoms of Necrosis, but are incompatible with those of an internal exfoliation; because the external lamella could neither acquire so prodigious a thickness, nor would there be room within it to permit so free a motion in the separated lamella. Mr CHESELDEN also describes purulent matter issuing through holes in the bone, in a manner exactly similar to the discharge in cases of Necrosis. So strongly indeed am I impressed with the idea of a mistake, that I cannot help thinking, that in some instances the life of the patient has been sacrificed to the want of performing a proper and reasonable operation to remove the sequestra.

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This opinion of an internal exfoliation involves a doctrine which is not supported by any fact or experiment. It supposes that the cancelli for containing the marrow are destroyed by disease; that the disease extends through part of the substance of the bone, but stops there, and produces a separation from the external shell, or lamella, which remains unaffected. Now, all this is a mere conjecture. The truth is, that all the experiments of Mr TROYA, and of every person who has repeated them, go to prove the direct contrary. Since from every one of them it invariably appears, that the total destruction of the marrow is the most certain means to occasion the death of the whole original bone, and to produce a new growth. And since in every other respect the analogy is so complete in all
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the circumstances which attend a case of Necrosis, it is scarcely possible to entertain a doubt, that the same consequences would follow, if the same experiments were transferred to the human body. It is indeed truly to be regretted, that no dissection was made of the limbs of those patients who fell victims to the severity of the supposed case of internal exfoliation of the tibia. The bare inspection of parts would have cleared up every doubt. And in my belief, it would have shown to satisfaction, that the moveable exfoliation was a complete sequestra of the whole substance of the tibia, and that the covering of bone was entirely a new production.

Internal exfoliations indeed frequently attack the bones of the cranium. I
have

have seen various instances of such exfoliations. But among a great variety of morbid affections of the long bones, I never have seen a single case which bore the most distant resemblance to what has been termed a case of internal exfoliation. And I never met with any history of a case supposed to be of this nature, which did not to me seem liable to many material objections. Indeed, the authors were all so palpably under some mistake or misapprehension, that I have no hesitation in excluding this case from any consideration in the diagnosis of Necrosis.

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SECTION XII.*Prognosis.*

IN predicting the event of a case of Necrosis, it is a satisfaction to be assured, that, upon the whole, the disease is not of a dangerous nature. It never attacks a part whose action or existence is essential to the preservation of life. In many of the bones of the body, the patient's life is never brought into danger by an attack of Necrosis. He always survives an attack upon the lower jaw and superior extremities, however tedious and severe the disease may prove. It is alone from attacks upon the inferior

rior extremities, the femur and tibia, that fatal consequences are to be dreaded. And even in them the attack is dangerous only in severe cases of the disease, and under very unfavourable circumstances.

An unfortunate termination may be expected, when the primary attack of inflammation is very violent, so that the symptoms succeed one another in a rapid succession, and with great severity. The immediate consequences of the attack, the pain, irritation and copious discharge of matter soon induce an incurable hectic fever. This form of the complaint is always a very serious one. It precedes the reproduction of the bone; and the degree of danger attending it, is to be estimated by the severity of the particular

particular symptoms, and by the height to which the hectic fever proceeds. In all cases of Necrosis, however, it is a consolation, the worst alternative which can be presented to a patient's choice, is that of submitting to lose his limb, in order to save his life.

If the patient surmounts the danger which attends the incipient stage of the attack, the succeeding stage is far less dangerous. For once the primary inflammation is mitigated or subdued, there is no particular danger to be apprehended while the new bone is forming. The duration, however, of this interval of security is very uncertain. And whenever the sequestra becomes moveable, and begins to irritate the internal surface of the new bone by friction,

tion, a return or increase of pain and distress may be expected. When the sequestra remains confined within its new covering, without making any effort to escape, the symptoms of the disease are seldom violent. Hectic fever, if it supervene at all, is in a moderate degree. But if the sequestra, in place of remaining at rest, shows a strong tendency to force a passage through the osseous shell, if this process proceeds with too much rapidity while the new bone presents considerable resistance, the sequestra, without completely extricating itself from its confinement, excites a very high degree of irritation, ulcerations spread all over the surface of the limb, and assume an unhealthy appearance, violent general fever succeeds, till at last the concurrence and continuance of

of all those severe and unfavourable symptoms, reduce the patient to a state of most imminent danger. This stage forms the last critical period of the attack, since the disease must here terminate either in the destruction or recovery of the patient. If the force of the disease prevails over the strength of constitution, death succeeds, or at least the patient must consent to lose his limb by amputation. If the strength of the patient's constitution subdues the virulence of the disease, then the sequestra is completely ejected, and nothing farther remains to interrupt the progress of the cure. In this stage, the estimate of danger is to be taken from the impression which the local affection makes upon the general state of the patient's health. If a morbid state of the soft parts produces

an ulceration all over the surface of the tibia, and a hectic fever takes possession of the system, then the safety of the limb is very greatly endangered. Comparatively speaking, however, this stage of Necrosis is not so dangerous, nor so completely out of the reach of help, as that which attends the violent attack of inflammation which supervenes immediately after the commencement of the disease.

Upon the whole then, it appears, that the Necrosis of the clavicle or superior extremities never proves fatal; and that even in the inferior extremities, although Necrosis always proves a tedious and severe disease, it very rarely terminates fatally. I never yet have witnessed an instance of the patient's life fall-
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ing a sacrifice to the attack: So that taking every circumstance into account, Necrosis appears to be in all cases a most distressful disease, but in very few a fatal one.

Method of Cure.

The ultimate object of all the foregoing researches is to ascertain the most judicious and certain method of cure; and happily there is no instance in which the successful investigation of the true nature of a disease can lead to more valuable improvements in practice.

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It is perfectly evident that an attack of Necrosis admits of no relief from any general treatment of the constitution. The disease is perfectly local, and is happily

SECTION XIII.*Method of Cure.*

THE ultimate object of all the foregoing researches, is to ascertain the most scientific, judicious and certain method of cure; and happily there is no instance in which the successful investigation of the true nature of a disease can lead to more valuable improvements in practice.

It is perfectly evident, that an attack of Necrosis admits of no relief from any general treatment of the constitution. The disease is perfectly local, and too deeply

deeply rooted in the seat of attack, to yield to the impression which any general remedy can make; so that any pretensions to cure, or even to relieve an attack of Necrosis by any course of internal medicine, is quite preposterous.

There is even much reason to question, whether any real benefit can be derived from the use of topical applications. It is true, the disease commences by an attack of inflammation. But then the inflammation is always so deep seated, and often so severe, that no local treatment has power to prevent or to check it. The common practice in cases of local inflammation, topical blood-letting, and the application of cooling astringent solutions, has little effect in this particular case. Because, besides the depth and

violence of the inflammation, there is probably some tendency to terminate in a peculiar way ; so that the means which are sufficient to counteract an attack of simple inflammation, prove less effectual in this. No other practice, however, is applicable on the occasion, and a trial of it is naturally suggested by the intensity and continuance of the pain ; so that whenever an attack of Necrosis is suspected, it is certainly advisable to try the usual means of counteracting inflammation : And it is clear, that whatever degree of efficacy these means possess, they can be attended with advantage only at the incipient stage of the attack. It must, however, always remain a matter of doubt, how far the use of them is beneficial, since the proof of the existence of the disease, immediately upon

its commencement, is too obscure to permit of much certainty. Yet as the practice is perfectly innocent, and cannot possibly prove injurious, no objection appears against giving the patient every chance of relief which the use of it affords. But if the attack be not at once subdued, or its approach averted, we must then expect the disease to follow its natural progress, in which art can do no more than to regulate the course of the attack in some particular circumstances.

The first period of danger is the most critical and delicate to manage. And as the safety of the patient's life is endangered from the extent and violence of the inflammation, before the new shell is formed, or the sequestra loose and ready

dy to separate, the assistance of art can be of little service, because any premature attempt to extract the sequestra by force, would necessarily increase the degree of inflammation, exasperate all the symptoms, and augment the patient's danger; so that the palliative and inert practice of applying emollient poultices and warm fomentations is all that the case admits of. If this treatment does not succeed, there is no alternative but amputation. Whenever therefore the patient's strength is sinking, from the effects of a hectic fever, and the local disease proceeding with uncontrollable rapidity, there is no room for delay. The constitution being in general sound, and in a state sufficiently favourable for an operation, the patient is almost certain to recover.

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But if the patient has the good fortune to survive this stage of the attack, or if the disease is not severe at its commencement, the case then presents itself under a more advantageous form to receive assistance from art. The removal of the sequestra may be accelerated. And indeed the sole object of practice through the whole course of the attack, consists in removing the sequestra at a proper time. It is likewise obvious, that there are two opposite states of the complaint, in which no interference is necessary, and where indeed it would certainly be prejudicial.

The first state is that in which the sequestra is dissolving and carried out of its place, without ever making its appearance

pearance externally, or giving any considerable disturbance to the constitution.

The second state is that in which the sequestra is escaping from its confinement, without violence, and without being the occasion of much uneasiness or inconvenience.

In both those states of disease the symptoms are so moderate, and the cure and recovery so certain, that every kind of assistance is wholly superfluous. Indeed, the chance is that it would tend to aggravate rather than to alleviate the distress. Because every operation is necessarily attended with pain, and followed by inflammation; and thus a great deal of distress may needlessly be produced

duced in a case where none would otherwise take place.

But in the intermediate state of the disease, where the presence of the sequestra is a perpetual source of irritation, the assistance of an operation becomes requisite to bring the disease to a happy issue by the removal of the sequestra. It is however a point of nicety to determine the proper time to perform the operation. Since the time of performing it may be too early or too late.

It is early and premature when the disease, though begun, is in the way of removing the sequestra, without either producing an external opening, or creating much disturbance to the constitution. Because, under these circumstances,

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ces, the case would terminate in a favourable manner, if left to follow its natural course.

It is too late when the case has been permitted to go on so long, that the sequestra is almost totally destroyed, and the cavity which contained it obliterated before any attempt is made for its extraction. For by that time the patient has been exposed to all the pain, inconvenience and danger, which the attack could possibly occasion. And the operation, far from relieving the patient, and accelerating the cure, creates distressing symptoms, which did not before exist, and thus prolongs its duration; so that an operation performed under these circumstances is not only unnecessary, but even highly pernicious, and ought therefore

fore to be avoided. Whenever, then, a case of Necrosis is presented for examination and advice, all these particulars should meet with due attention before we deliver our opinion on the subject.

Two principal varieties of the disease come more immediately under consideration. The one is that dubious case in which the existence of the sequestra is not marked by the presence of any external visible obvious symptom.

The other case * is that in which a portion of the sequestra is either simply naked and exposed, or else with the extremity projecting, and in the act of endeavouring to force its way out, but prevented from escaping, by the resistance it

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* Plate V. fig. 1, 2, 3.

meets with from the partial or complete formation of an osseous shell.

To consider those two cases in their order.

In the first case we must be satisfied of the existence of the Necrosis, and of the presence of a sequestra, to justify the idea of an operation. And even then, if the pain be moderate, and the patient suffers little inconvenience from the complaint, an operation is quite superfluous. But on the contrary, if, along with the same obvious marks of Necrosis, the patient suffers severe local pain in the limb, if his system is perpetually harassed with symptomatic fever, and his strength daily declining, from the greatness of the irritation, and the profuse evacuation of
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matter, it then becomes a question of prudence, to determine how far an operation will afford him relief. There is not the smallest doubt that if a large sequestra be imprisoned and cannot escape, the division of the casement, and removal of the sequestra will be of the most essential service, and procure immediate ease. But then the difficulty consists in ascertaining the exact state of the parts which lie within the centre of the limb, concealed from sight. We may expect, however, to arrive at an approximation to the truth, by adverting to different circumstances. Of these, two of the most material, are the duration of the complaint, and the age of the patient. Since it is obvious that the longer the disease has continued, the sequestra will have made the greater progress in falling into
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decay, and that the celerity of its dissolution will be much modified by the patient's age. A case of Necrosis in a grown subject, in whom the sequestra is large and solid, and the actions of the system more tardy, requires a longer time to finish its course. In a young subject, on the contrary, every one of these circumstances favours a more speedy termination of the case. The complex nature of the investigation, indeed, does not admit of perfect accuracy. But there is one case which throws much light upon this point of the subject. It has sometimes happened that both limbs have been affected with Necrosis at the same time, and attacked precisely together; both of them likewise have been the subject of operation, and, from motives of prudence, the two operations have been performed

performed at a considerable distance of time from each other. In this interval, the parts had undergone great changes. And, as the two cases were in all respects similar, the changes undergone, measures the progress of the disease in this interval of time. In one patient, a lad of eighteen, the first operation was performed about three months after the commencement of the disease, and a large sequestra extracted. Five months after this, the same operation was performed upon the other leg. But by this time there was scarcely a vestige of the sequestra remaining, and the cavity of the bone was nearly obliterated. In another patient of thirteen years of age, the result was wonderfully similar. But, as the patient was somewhat younger, the progress of the disease was rather more

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rapid. Accordingly, in the interval of five months, there was not a vestige of the sequestra left remaining, and the cavity of the bone was more nearly obliterated. In both cases too the new bone was harder, more solid, and infinitely more difficult to cut at the time of the second operation. So that, by comparing the two periods of operating, the superiority of an early operation appears in a very strong light. Indeed, in both cases the second operation was quite useless, and perhaps pernicious, since nature would, without the assistance of art, have completed the cure in a very short time, and in a much easier manner. In like manner, in other cases where the operation had been postponed to a late period, the cavity was nearly obliterated, the sequestra nearly consumed, and the
osseous

osseous shell consolidated to a degree of hardness which made the excision of a portion of it almost impracticable.

The practical inference to be deduced from these facts is apparent. It follows, that whenever we are satisfied of the existence of a case of Necrosis, and from the violence of the symptoms, convinced that the patient must expect a long continuance of suffering, with a tedious and uncertain cure, it is clearly of advantage to operate early, since by that means we not only abridge the duration of the patient's distress, but from the superior softness of the bone operate with greater facility. It is farther evident, that the advantage gained by avoiding delay is the greater the farther the patient is advanced in life, because, from the greater

size and hardness of the bone, the case would necessarily prove more severe, and be protracted to a greater length. The exact limit of time which affords most advantage from operating, cannot indeed be given with perfect precision, though perhaps about three months from the commencement of the attack is the most proper time to decide upon the line of practice. By that time the disease is completely formed, and has made sufficient progress to indicate the course which it is likely to follow. It is not unusual too, that at this period the disease puts on an alarming appearance, which induces the patient to apply for advice.

These are the indications which arise from considering the age of the patient and duration of the disease. But besides

sides this source of information, we may derive assistance by attending to the local circumstances of the case. If, for example, the pain be abating, and the discharge of matter diminishing, it is probable that the sequestra is consuming very fast, and will soon be completely destroyed. To confirm this idea too, it is possible to examine the state of the bone, without proceeding to any severe operation. For this purpose it is sufficient to uncover different portions of the bone, of no great extent, near where the fistulous openings are, and by introducing a probe, or, if that be impracticable, by making perforations with a small drill, to explore the state of the cavity. If, upon this examination, we discover that the cavity still is extensive, and contains a sequestra of considerable

size, the necessity of operating becomes apparent. On the contrary, if the whole of the cavity be filled up with osseous matter, and no remnant of sequestra is to be found, these circumstances clearly indicate the propriety of trusting the cure entirely to nature.

These seem to me the considerations which ought to regulate the conduct of a practitioner at the first period of the case, in which the sequestra does not appear externally.

In the other period for operation, the point of practice is not nearly so delicate, nor so difficult to decide; for then the exposure or protrusion of the sequestra removes all uncertainty as to the nature of the case. Under these circumstances, an
operation

operation is in general advisable to accelerate the removal of the sequestra, and in some cases its speedy removal is absolutely necessary, in order to save the patient's life. The only cases indeed in which an operation may be dispensed with, are these in which the sequestra separates so slowly as to cause no sensible degree of irritation. In cases of Necrosis of the femur, indeed, this point doubtless is of very material importance, because the bone lies at a considerable depth through most of its extent, the exact state of the disease cannot be so accurately known, and the operation to be performed is infinitely more severe. But in the tibia, where the covering of soft parts is more moderate, much less reserve is necessary; and unless there be a total absence of pain and of uneasiness
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of every kind, the sequestra ought immediately to be removed. In truth, the indication is so extremely obvious, that when the surgeon is entrusted with the management of the case from the beginning, there is little opportunity to commit any mistake of material detriment to the patient.

But if the patient by negligence, or from want of opportunity, has allowed the complaint to proceed to an imprudent height, the most advantageous season for operating may then be irrecoverably lost. Still, however, this is no reason to withhold the assistance of an operation; for although it may prove less effectual than we could wish, yet it will be attended with no danger, and will neither accelerate the progress nor aggravate the severity

severity of the case. Even in the most unfavourable and desperate circumstances under which an operation would be attempted, the removal of the sequestra may afford some temporary mitigation and relief; so that it seldom is too late to operate, however little benefit we can promise the patient from the success of the practice.

Thus it appears, that the removal of the sequestra is the only mode of practice admissible in a case of Necrosis; and that when the existence of the disease is clearly ascertained, and the irritation produced considerable, we can scarcely be too early in performing the operation to extract the sequestra. On the contrary, that we shall be infinitely too late, if we delay operating until the sequestra

questra be totally consumed, and the cavity completely obliterated. In these cases, the sequestra is concealed from sight, by the surrounding growth of new bone. But in the other class of cases, in which the sequestra appears externally, either by exposure or protrusion, there is no time too late to operate; and it is plain, that, in such cases, we never can operate too early.

The preceding observations properly pertain to idiopathic cases of Necrosis, which arise without any external injury, though with very little change they may be transferred to those cases which are occasioned by the irritation of a compound fracture, and thus have a very different origin. The progress, however, of those symptomatic cases may be exactly

exactly similar to the others, and they admit of an equally great variety in their mode of terminating. For sometimes the fragments of the old bone, which corresponds to the sequestra, become inert, and remain imprisoned within the new shell, without producing any inconvenient degree of irritation. At other times they prove the source of incessant and intolerable irritation, and require to be immediately extracted, by the removal of a portion of the new osseous shell. The prudence of either line of practice will depend upon the exigency of the symptoms, though in general a considerable degree of irritation seems to be an inseparable attendant of a Necrosis forming from this cause. As yet, however, there is no observation in point, to determine whether the fragments of the broken

broken bone have ever been dissolved and removed by absorption, and the new formed cavity filled up and obliterated, though there seems nothing in the nature of the case inconsistent with this termination. The formation of the new shell extends no farther than what is sufficient to include the whole extent of the fractured portion. The nature of its substance is exactly the same as in other cases of Necrosis, and the cure must be conducted upon similar principles.

In certain parts of the body, an attack of Necrosis never leads the surgeon into any dilemma with respect to the existence of the disease, the presence of the sequestra, or the necessity or propriety of removing it. All attacks upon the lower jaw are of this class; for as the old bone
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never is completely furrounded by the new one, it cannot be so long confined as to prove a permanent cause of irritation. In such cases, accordingly, we have not so much to apprehend inconvenience from the too long confinement of the sequestra, as from its too speedy separation. And this disparity of circumstances leads to an inconvenience of a totally opposite nature; because, in consequence of it, the old bone frequently comes out prematurely before the new bone is fully consolidated, so that the chin becomes flexible and pendulous, and loses its natural form. When this accident happens, it becomes necessary to substitute some artificial support, in place of the natural one which is withdrawn. And if by the application of a solid frame,

frame, the soft parts be all retained in their proper relative places, the rudiments of the new bone, if it be already laid, will gradually consolidate, till at length it acquires the requisite degree of solidity, firmness and strength to perform the office of the original jaw. This is the only management requisite in such cases.

There is likewise a peculiarity in some cases of Necrosis of the long bones, which require a similar management. It was before mentioned, that in certain cases the sequestra separates at both extremities before the new shell has time to become firm, and afford support to the limb. This variety of the attack, however, is not attended with pain or with danger, and the concomitant inconveniencies are easily

easily corrected. Since all that is necessary is to keep the leg extended upon a common splint, until it has acquired sufficient firmness to support its own weight, without bending or breaking.

This finishes all the remarks I intended to offer upon the nature and treatment of Necrosis, and nothing farther remains but to explain the operation necessary to perform for the extraction of the sequestra; but before proceeding to this branch of the subject, it will be proper to advert to a proposal which has been made to attempt the dissolution of the sequestra, by injecting an acid liquor into the cavity of the new bone. The muriatic acid in a diluted state is the best adapted to this purpose. It is sufficiently efficacious as a solvent, and not the most ir-

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ritating as a stimulant. At the same time, I should be afraid there was no possibility of sufficiently guarding against the inconveniencies of injecting an acrid liquor into the cavity of the new bone. If the sequestra be very large and very solid, it must require a long time and a frequent repetition of the injection to dissolve it completely. And all this while, the whole internal surface of the new bone must be exposed to the action of the solvent. Nor is there any means of computing the pernicious consequences which this exposure may produce. The experiment has never yet been made, and probably never will, as it is not easy to conceive any advantage which a cure by a chemical menstruum possesses over one by a mechanical operation. It certainly would not be proper

per to attempt a cure by injection, except under the same circumstances that it would be advisable to operate ; and in using the injection, there always would be some difficulty in determining whether or not the sequestra was completely dissolved. In no respect, then, is there any motive to give it the preference over the common and more simple method of cure. It is only applicable under the same circumstances, it is more tedious and more troublesome in its use, more uncertain in its effect, and probably infinitely more painful and more dangerous in its consequences ; so that I regard this proposal as one of those speculative projects in surgery which does not merit a trial in practice.

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The Operation.

THE operation to be performed in cases of Necrosis is neither delicate nor difficult, and requires no superior judgment or dexterity. It consists in extracting the sequestra through an aperture in the new osseous shell.

The parts exposed to be cut do not endanger the patient's life, and are not remarkably sensible. The first step of the operation is to lay bare the bone; and this may be accomplished either by means of a scalpel or by the application
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of caustic. But the former method is far preferable, both because it is more expeditious, and does not necessarily subject the patient to the loss of skin. Besides, the operation of caustic is more painful, and the depth and extent of its action more uncertain. The use of caustic, therefore, seems to be without advantage, and is wholly inadmissible.

The place, direction, and extent of the external incision is to be determined by the number and situation of the fistulous openings in the skin. A portion of the new bone under one of these openings, sufficient to permit the surgeon to explore the state of the parts beneath, is first to be laid bare. In this space he will probably discover an opening in the bone, which leads directly to its internal cavity; for in general every exter-

nal fistula is produced and supported by such an opening, and corresponds nearly to the place of it. If this opening in the bone be so narrow or so irregular in its course, that a probe cannot be made to pass, then, in order to ascertain the exact state of the disease, the next step is to bore a small hole in the bone, by means of a perforator or common drill. If the bone be hollow, with a large cavity in the centre, the perforator, after penetrating through the thickness of the osseous shell, will go suddenly down from the want of farther resistance; because there is nothing to oppose its progress, till it meet with the internal surface of the shell on the opposite side. Here it is again stopped, and by measuring the distance between the cessation and renewal of the resistance, we ascertain the length of
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of the diameter of the cavity of the new bone. A number of similar perforations made at different distances, and at such places as the external openings indicate, determine the state of the central parts of the bone. Because, if the cavity be filled up, the perforator is always felt to be cutting a stratum of solid matter. The pain which attends the making of these perforations is not considerable; but it is of consequence that the point of the perforator be always so directed as to pass through the centre of the bone, in order that it may afford a fair measure both of the thickness of the shell and of the diameter of the cavity; because, if it passes in any other direction, the obliquity of its course gives a false measure of all the parts through which it passes, the thickness of the bone appearing greater,

greater, and the diameter of the cavity less than the truth. By this false estimate, we should judge the cure to be nearer complete than what it is in reality, and consequently neglect to pursue the necessary measures. After the perforatoris withdrawn, we may introduce a probe in its place. And if the perforation be large, and the probe small, then it admits of being bent, so as to explore the state of the whole internal cavity, and determine both its extent, and whether or not it contains a portion of undissolved sequestra. By proceeding in this manner, we have it in our power to ascertain all the circumstances which are requisite to be known previously to the last and most essential step of the operation,

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The skin, if it be in a sound state, need not be removed, when the portion of bone to be removed is not of great extent. But if either the skin be unsound, or a considerable portion of bone is to be cut out, it then becomes necessary to remove a corresponding portion of the skin. It may be observed too, that the separation of the skin from the bone is more troublesome than in ordinary cases, because the adhesions are greater, and the division of parts less distinct, in consequence of the previous inflammation, and the want of the periosteum.

The temporary hæmorrhage which occurs in cutting through these parts, is neither considerable nor troublesome, and seldom is so profuse, or continues so

so long, as to disturb or impede the operator.

After all the superficial parts are removed, the next step is to cut out a portion of the new formed bone; and when this is still in a soft state, the whole of the operation may be performed by means of a common scalpel, provided it be strong, and of a large size, because the stratum of new bone, previous to its complete ossification and consolidation admits of being cut with a sharp knife. This, however, is but rarely the case at that period of the disease when an operation is requisite for the removal of the sequestra; for by this time the ossification of the new shell is in general so complete, and every part of it so firmly consolidated, that no instrument makes any impression

pression upon it, which is not capable of cutting through a hard, solid and thick bone. A saw of some kind, therefore, is commonly requisite to complete the operation; which may be performed in two different ways. The operator may either make a number of different perforations with the head of a trepan*, placing them in contact with each other, so as to form one continuous opening; or he may make a deep incision at the top and bottom of the bone, by means of a circular saw, and then cut out the intervening portion, by the use of a googe and mallet. The last method is the most expeditious. But it is not equally well adapted to every case of Necrosis; for when the bone is thick and hard, the googe does not easily cut through

* Plate V. fig. 6. and 7.

through so firm and solid a substance. Accordingly, cases have actually occurred, in which it was scarcely possible to complete the operation, by means of these instruments. It likewise exposes the operator to greater risk of cutting out more of the bone than what is absolutely necessary, and thereby making an opening, and leaving a fore of superfluous extent. No person, therefore, would wish to employ this method of operating, when the bone is very thick and firm, and the size of the sequestra unknown; so that the advantage of expedition is fully compensated by other less favourable circumstances.

The use of the trepan is not liable to these objections. There is no hardness or thickness of bone which it is unable

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to penetrate and remove. If it is not so expeditious, it is more certain; and as the aperture is gradually extended, we have it in our power to stop whenever a sufficient width is opened to permit the extraction of the sequestra: For as this is the ultimate object of the operation, the possibility of extracting it is a measure of the requisite aperture. The gradual enlargement of the opening likewise affords us an opportunity to judge how far any advantage may be gained, by breaking down the sequestra into separate pieces; for if it be of a large size, we may often very much facilitate the extraction of it by this means. It also frequently happens, that the sequestra is firmly wedged in at the extremities, though it be loose at every other part; and in these cases, removing a portion
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from one end, allows the whole to be easily withdrawn. By this expedient, we save the patient all the inconvenience of making a larger opening, and of leaving a larger extent of surface in the state of an open sore; so that whenever the aperture in the bone is of sufficient size to permit the extraction of the sequestra in separate pieces, it always is advisable to have recourse to the division of it. In general, it may be divided by means of cutting pliers; or if it be too hard and solid to yield to them, it is always possible to remove a portion of it, by applying the head of a trepan; in one way or other the object is certain of being attained.

The exposure or protrusion of the sequestra makes no material difference in
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the operation. It removes indeed all uncertainty as to the existence of a cavity containing a sequestra, and helps to determine the direction of the incision, and the number of perforations requisite, and on these accounts renders every circumstance easier. But after the sequestra is removed, the limb is exactly in the same condition in both cases. It is plain too, that after the perforations have been made by the trepan, it is necessary to remove the angular prominencies, by means of some other instrument.

The removal of the sequestra completes the operation, which, though tedious, is not painful in proportion to the severity of its appearance. The patient no doubt suffers distress, and the length of his sufferings

ferings may wear out his patience, as the operation sometimes lasts for half an hour, or even for a longer time. But what he suffers is not sufficient to induce faintness, or to excite such a degree of irritation as is likely to be followed by much fever, consequently the after symptoms are in general sufficiently mild.

The mode of dressing the fore after the operation is not a matter of difficulty. The simplest dressings answer best. A large emollient poultice, which covers the whole limb, gives the least irritation, and ought therefore to be preferred. It requires to be changed three times a-day. In less than a week, the whole surface of the fore assumes a healthy aspect, and the cavity of the bone becomes

becomes covered with granulations *. These granulations gradually extend themselves till they fill up the whole cavity, and reach the level of the surface. They are of a more solid consistence than the granulations which rise from the common soft parts, and have much the appearance of a piece of healthy gum. After granulations have arisen from every part of the surface, and a healthy suppuration is established, it is no longer necessary to continue the application of the poultice, and in its place a dressing of simple ointment may be substituted. No farther alteration of dressing is required in the ordinary circumstances of the cure.

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* See Plate IV.

The growth of the granulations gradually fills up the cavity of the new bone, and once they have arrived at the level of the surrounding parts, their surface is covered over with a thin pellicle of skin. This pellicle becomes by degrees thicker and firmer, till it at last arrives at the state of a perfect cicatrix. In this way the wound closes before the ossifications have pervaded the whole substance of the granulations; but in time every part acquires a proper degree of firmness, though the progress of the change can no longer be observed.

The cure, from the removal of the sequestra till its final completion, requires, in cases of Necrosis of the Tibia, from four to six months; and in other bones a longer or a shorter time, in proportion
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to their size, and to the age of the patient.

At the beginning of the cure the patient must confine himself to bed, and must continue in it till the granulations have grown to the level of the surface, and have begun to receive a covering of skin. After this period he may be indulged with greater liberty, but must at all times be cautious of overdoing, and content himself with walking short distances at first, with his leg suspended in a sling.

The treatment of the constitution under the cure is not difficult, as the fore in general forms a simple ulcer, which requires no particular management of the patient's general health. If any

pain, irritation or restlessness succeed the operation, a dose of laudanum will compose the patient, and ought to be repeated occasionally, if the return of uneasiness makes it requisite. The articles of diet should be such as are sufficiently nourishing, without being too stimulating. At first it should consist chiefly of vegetable food, and in the progress of the cure of a moderate allowance of animal food. Care must likewise be taken to obviate any troublesome degree of costiveness, and with due attention to all those different particulars, there is seldom much difficulty in conducting a case of Necrosis to a happy termination.

When the cure is finally completed, the substitute bone is filled up with solid matter, and becomes in every respect

similar to a case of Necrosis, in which the sequestra had been wholly consumed, without making its appearance externally. The affected limb indeed is left larger and less shapely than the other, but in fulfilling all the useful purposes of life, its functions are no ways impaired; for the patient is not sensible of bearing an additional weight, nor does he suffer any other perceptible inconvenience.

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CONCLUSION.

THE appearances which a case of Necrosis exhibits are so striking, that one might expect them to have attracted the notice of the earliest practitioners in surgery, and to have been recorded in the writings of the first authors; yet notwithstanding the very curious nature of the disease, no mention is any where made of it till the time of ALBUCASIS, an Arabian Physician, who is supposed to have lived towards the close of the eleventh century; and the description which he gives of the case, proves clearly that he did not understand the nature of it. After this date a long interval of silence succeeds,

ſucceeds, and no farther mention is made of the diſeaſe till fix hundred years after the æra of ALBUCASIS, when SCULTETUS, an eminent German Surgeon, gives a wonderfully diſtinct and accurate deſcription of a caſe of Necroſis, and of the operation performed to cure it. It is ſingular, however, that ſo memorable a caſe, and ſo ſucceſſful practice, had no immediate tendency to advance the knowledge, or to improve the treatment of the diſeaſe. For ſoon after SCULTETUS publiſhed his work, we find authors of the firſt note in the profeſſion deſcribing caſes of Necroſis with little intelligence, and with that blind admiration of particular ſymptoms, which is the never failing concomitant of ignorance. So ſlow, indeed, has the progreſs of improvement been, that even ſome of the moſt eſteem-

ed authors of modern times do not appear to have understood the disease with much accuracy. The celebrated Mr CHESELDEN most certainly mistakes a case of Necrosis for a disease of a very different kind. Mr GOOCH of Norwich performed a successful operation, in a case of Necrosis, consequent to a compound fracture of the Tibia, without seeming to understand the nature of the affection. And the late Dr WILLIAM HUNTER, who has left some elegant designs of the most interesting morbid appearances which occur in Necrosis, is quite unable to offer any adequate and satisfactory explanation of the manner in which they were produced. To this list of distinguished men I might, if it were necessary, add the names of some respectable living authors; so that I am sufficiently

ciently authorised to consider the true nature of Necrosis as not yet fully and generally understood. I might farther add, that the ignorance of some of the most important particulars, has introduced a line of practice far from judicious and correct.

In this imperfect state of our knowledge, a field of improvement still remained open, to reward the labours of those who chose to prosecute the inquiry; and as my situation afforded me many opportunities to observe cases of Necrosis, under all their various forms, and my inclination led me to bestow particular attention upon the subject, I soon found that my collection of materials was sufficient to illustrate the principal points of the disease. I was fully persuaded
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that a systematic view of the subject was wanting, and that the only way to lay the foundation of any solid improvement in future, was to connect all the insulated facts by some general principle. To fulfil this object, I have endeavoured to arrange my thoughts in the form of a methodical system, which, however deficient in other respects, at least possesses the merit of originating from the actual examination of the appearances in nature.

THE END.

Explanation of Plates.

THE annexed plates are intended to illustrate the different circumstances which occur in a case of Necrosis: And as the original drawings were all taken from nature, immediately under my own inspection, I can thoroughly trust to the accuracy and fidelity of the representation.

But before I proceed to give a particular explanation of the different figures, it will be proper to consider the true import of the term Necrosis, and the particular circumstances which it is employed to denote. The term is of Greek original, derived from the word *Νεκρος*, which signifies dead. Accordingly, in the application of it to the disease in question,

tion, reference is more directly made to the decay of the old bone than to the formation of the new one, and in so far it gives but a partial view of the disease: For although the death and separation of the old bone be the most obvious and striking symptom, it is not the most curious and important; so that in this respect the term Necrosis is not happily chosen. It will therefore be of advantage to confine our attention solely to the essential symptoms of the disease, without regarding the etymological meaning of the name.

In every case of Necrosis then, we ought to remember, that the formation of new parts constitute an indispensable symptom of the disease; and it is the chief purpose of these plates, to explain the

the manner in which these new parts form, and the appearances which they ultimately exhibit. But while this is the first and principal object, they likewise represent the different progressive steps which accomplish the separation and ejection of the old bone.

The three first plates are intended to illustrate the progressive changes which take place in the formation of the new parts.

In the first, the change is represented as complete. Accordingly, we there see a portion of the old bone, very much eroded by disease, inclosed within a newly formed shell, which entirely surrounds it. This figure then represents the characteristic symptoms of a case of Necrosis,
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in its complete state; and it is evident from inspection, that the new osseous shell forms the most curious and interesting part of the preparation.

In the second plate the disease is not so far advanced. The formation of the new bone indeed is perfectly distinct, though it does not yet form a complete cylinder.

The third plate represents the disease in the incipient stage, when the rudiments of the new bone are beginning to form. The continuity of the old bone is still preserved, but towards the two ends an erosion is beginning, and which, by increasing in depth, will at last produce a complete separation. The most interesting appearance, however, is the accumulation of a quantity of soft matter along
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the whole length of the limb. In this stratum are deposited the osseous particles which form the new bone. The ossification is already begun in one spot, and by extending itself, will at last complete the consolidation of the substitute.

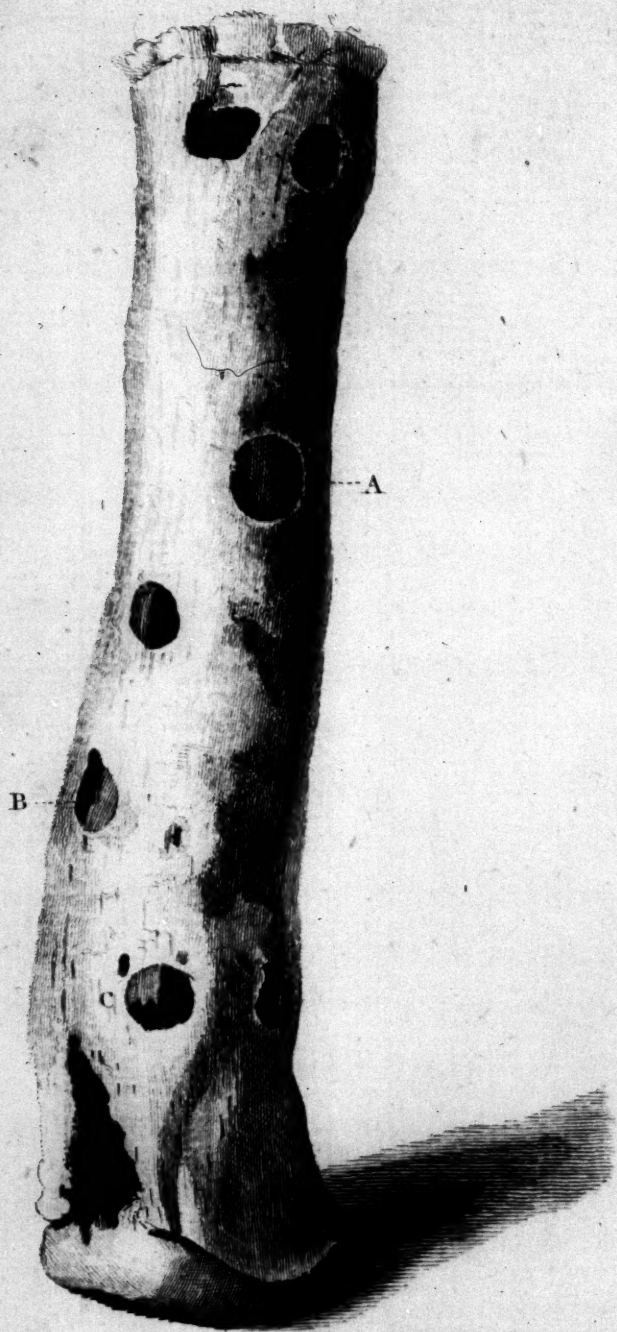
Thus the inspection of those three plates serves to explain the progress of a case of Necrosis.

It is perhaps no easy matter to give a concise, clear and technical definition of the term Necrosis, though the meaning which it is intended to convey will be sufficiently understood, by attending to this short description of the leading appearances represented in the annexed plates, especially if the more full explanation of the particular plates be read at the same time.

The same name is likewise extended to cases which are not altogether similar in their circumstances, although the cure be conducted upon the same principles. To those cases, for example, in which a portion of the original bone being removed by design or accident, the neighbouring parts deposite a stratum of ossific matter, which at last consolidates into solid bone. This case, however, does not occur frequently: There can be no sequestra nor hollowness in the substitute, so that it never follows the progress of an idiopathic attack. The necessity, therefore, of including it as a necessary part in the definition of the disease may possibly be questioned, though there can be no doubt of the propriety of explaining it as an appendix.

Explanation.

PLATE I.



D. L. Sculp.

Explanation.

PLATE I.

THE figure represented in this plate exhibits the usual appearances of a case of Necrosis of the Tibia, in which the cure is completed, without the ejection or destruction of the original bone. Accordingly, we have here a distinct view both of the new formed osseous shell, perforated with holes, and of the sequestra included within it, and lying loose. The letters A, B, C, indicate the holes through which the sequestra may be seen, C indicates the lower extremity. The upper extremity is concealed from sight,

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by a portion of the osseous shell which is not perforated. At A, where the whole thickness is visible, the sequestra appears smaller than what the diameter of a tibia of this length ought to have been in its natural state. But to explain this, two circumstances are to be noted. First, that the substance of the tibia may have been somewhat wasted by that decay which a bone suffers when it becomes dead, and loses all connection with the living part. Secondly, it would be fallacious to imagine, that the sequestra had ever equalled the length of the new shell, as this shell may have been considerably elongated since the time that the sequestra separated from the remaining extremities of the tibia. Probably there was in this case an interval of years between the time of the separation of the
sequestra.

sequestra and the death of the patient, and during all this time the substitute bone would continue to grow, while the sequestra would necessarily remain of its original size. Thus, the disproportion between the size of the sequestra and of the substitute bone is a necessary consequence of the circumstances of the case at the time of the patient's death; and the great mobility of the sequestra is sufficiently accounted for.

The general aspect of the figure represents the external appearance of the substitute bone. It has no regular shape. It is much thicker in proportion to its length than any bone of the human body. There is a total want of those characteristic features which mark the form of every original bone in its natural state.

There are no particular hollows, or rough and prominent edges to serve for the insertion of muscles, no distinct variation of form in different parts, no regular apophysis. In short, there is nothing graphical about it, to appropriate the figure peculiarly to a certain bone of the body.

At the lower end the cartilage is distinctly seen, with a more extensive surface than is usual. This extension of surface corresponds with the changes which takes place in consequence of the enlargement of the bone, and is one of those concomitant circumstances which necessarily attends a case of Necrosis. The new shell is perforated with a number of holes, disposed at unequal distances, and in an irregular manner. There
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are in all seven visible in this point of view. The regularity of their shape is very remarkable. They are all smooth at the edges, which are worn thin, and bevelled from the inside, like the holes of a musical wind-instrument. Their form, and the shape of their edges, is produced by the constant discharge of purulent matter through them, which disposes the holes to assume a circular shape, and wears their edges thin. The number and position of these holes is purely accidental, and their commencement is coeval with the original formation of the new bone,

These are the most remarkable particulars which present themselves on the inspection of this figure, which very clearly exhibit the essential characters

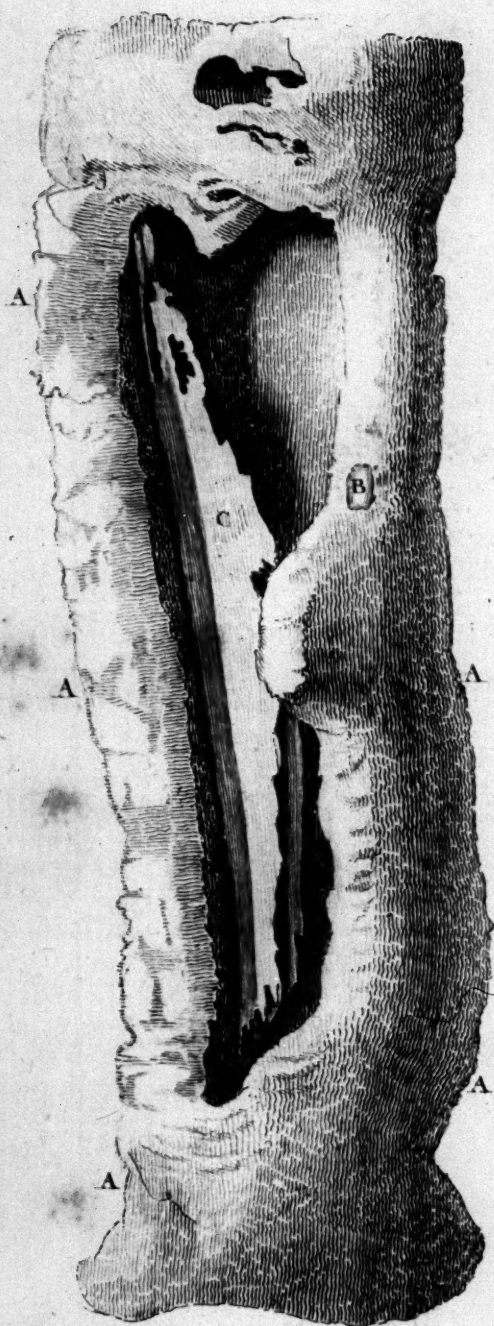
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of a bone formed in consequence of Necrosis.

The irregular shape of this bone naturally suggests a doubt how far the action of the muscles contributes to give a particular form to the original bones of the body, since this substitute bone was subjected to the action of the muscles of the leg during all the time of its formation, without assuming any characteristic shape, in consequence of their action. But as this question is more of a speculative nature than what belongs to the proper subject of this essay, I shall wave any farther discussion of it on the present occasion.

Explanation.

PLATE II.



D. Lizards Sculp!

Explanation:

PLATE II.

THIS figure represents a case of Necrosis of the Tibia, in an intermediate stage of advancement. The formation of the osseous shell A A A, A A A is complete, excepting at the anterior part. But here there is deficiency the whole length of the bone, nearly equal to one fourth of the cylinder. Through the opening which this deficiency leaves, the sequestra C is seen lodged in the hollow of the new bone. It extends almost the whole length of the hollow, and when it was entire, must have occupied nearly

all the empty space. But in its present state it is considerably decayed, especially towards its two ends; and here, in particular at the upper end, it exhibits that ragged prominent pointed appearance which so much characterizes the extremity of a sequestra. Near to the top, a hole is eroded through the whole thickness of its substance. A small portion is likewise destroyed upon one side, which makes the cylinder imperfect. But the other sides are in their natural state, with smooth surfaces and angular edges.

The osseous shell A A, &c. is open on its anterior edge from one end to the other, but originally the cylinder was complete near to the middle, so that the openings above and below were separated from each other, by a portion of bone

bone nearly an inch in length. It was necessary, however, to remove this osseous bridge, in order to permit the extraction of the sequestra; and it is this circumstance which has given the appearance of a complete deficiency on the anterior part.

This new osseous shell is fully ossified through the whole thickness of its substance, and is perfectly firm, solid, and strong. It is very full of blood-vessels, so that the central parts have been made red with injection. The two surfaces, especially the external surface, is covered with soft granulations, about an eighth part of an inch thick; and when these granulations are removed, the surface of the bone itself is tolerably smooth. The surface of separation between the bone
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and the granulations is perfectly distinct, there being no gradation in the conversion of the one kind of substance into the other. What is not consolidated is quite soft. And the ossifications do not always take place in immediate contact with the surface of the osseous shell, and by adhering to it increase its bulk by gradual additions. On the contrary, it is more usual for an ossific nucleus to form at a little distance from the surface of the parts already ossified, and after it has increased in size, to attach itself to the new shell. An ossific nucleus of this kind is denoted by the letter B. It is about the size of a common barley-corn, and is entirely unconnected with the other ossified parts. In this respect the process of ossification in the new shell agrees with its progress in the formation of

of the original bone. Though this circumstance is more apparent in the earlier periods of the attack, the texture of the new bone appears at that side which is straight and flat; and from the inspection of this figure, it is evident that it is not composed of concentrated lamellæ, such as would be seen in a longitudinal section of an original tibia, but is more of an homogeneous texture, though the fracture is not quite smooth. The edge of one side lies nearly parallel with the surface of the sequestra; and some such accident has probably given rise to the opinion, that a new bone had been formed along side of the old one. There does not, however, seem to be any justice in the opinion; and perhaps, upon more accurate examination, the rest of
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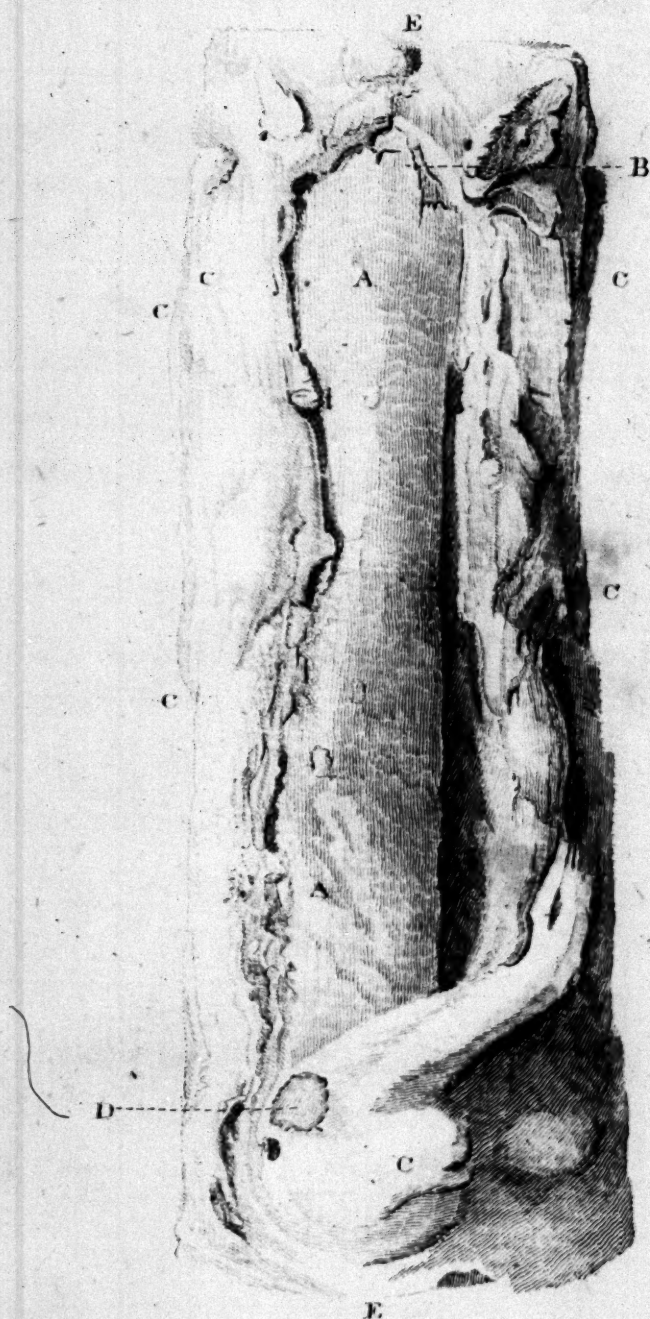
the osseous shell would have been discovered, and have explained the illusion.

From the best account which could be collected of the history of the case, the disease must have existed about ten or twelve months.

The figure is drawn to a scale nearly of one half of the size of the original.

Explanation.

PLATE III.



Plazet's Gulp.

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Explanation.**PLATE III.**

THE preparation which this figure represents, was taken from a case of Necrosis of the Tibia, in which the disease had lasted only for twenty-four days from the commencement of the attack. It therefore exhibits the formation of new parts in their incipient state, and thus serves to illustrate the first and leading steps in the progress of the disorder.

The tibia A A appears in the middle, in its natural place, and very nearly of its

its natural appearance. It still forms one entire piece, though the whole seems to be in a state of high inflammation, as it has an unusual and preternatural degree of redness over the whole surface; and as this great degree of redness proceeds from the general diffusion of a size injection, it shows that the connection between all the parts of the bone still remains uninterrupted. At one place B, however, near to the upper end, a separation is already beginning to take place. As yet, indeed, it has not made any considerable progress. But as the process of ulceration was sufficiently rapid, it soon would have effected a complete separation of the bone, though until the separation was completed, the bone would continue to serve as a useful support to the limb. A similar erosion had actually

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ly begun towards the lower end, though it was concealed by the covering of the adjacent parts. When the separation was complete in both places, the middle portion would be entirely detached from the two extremities, and thus form the sequestra of a Necrosis. Here then we plainly discover the origin of the sequestra, and may easily trace the way in which it is produced.

Next, as to the origin of the osseous shell. All around the bone, A A, there is deposited a stratum of soft materials, C C C C. This stratum is in most places nearly half an inch thick. It is extremely vascular; uniform in its texture, and somewhat firmer in consistence than the granulations which rise from soft parts in a healthy wound. But in the other parts
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of its structure, it very much resembles them. The opening which appears in the separation, was made by the incision of a knife, in order to give a view of the parts beneath; for the stratum of new matter went completely round the leg, and concealed them from sight. In general, the ossification had not begun, but in one point, D, an ossific nucleus is perfectly formed, and probably the whole mass was in a state which prepared it to assume a similar change. In a very short time, therefore, the ossification might have taken place through all the substance of the deposited stratum. For after ossific granulations are in a fit state for ossifying, the consolidation of the whole mass may be completed in a short time, by the ossification beginning in different places at once. And this seems

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to be the ordinary course which the process follows, both in natural and morbid cases. In some instances, indeed, ossific spiculæ proceed from a common centre, and radiate after an irregular manner, and to a considerable distance, much like the ramification of a vein of metal in its matrix. When this process obtains, which is but rare, all the ossifications are connected together from the first. In the other case there are separate points of ossification, but the ossific nuclei soon unite together, and compose one continuous mass.

These are the principal appearances which present themselves to view in the examination of this figure, and they serve well to illustrate various leading circumstances in the history of the disease.

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They show clearly that the new bone begins to form before the old one separates and dies, and even that it may be consolidated and able to bear the weight of the body before the other becomes useless. All this appears, by observing that the sequestra is not nearly detached from the extremities of the tibia, while a complete stratum is laid for the deposition of osseous matter, and the ossification is already complete in one place. Hence it is easy to conceive by what means a patient may preserve the power of walking during the pendency of the disease, when the case is mild. It is farther obvious, that there is no necessity the marrow should be killed or destroyed, previously to the commencement of the new shell.

E E, the extremity of the tibia.

Explanation.



PLATE IV.

Fig. 2. D

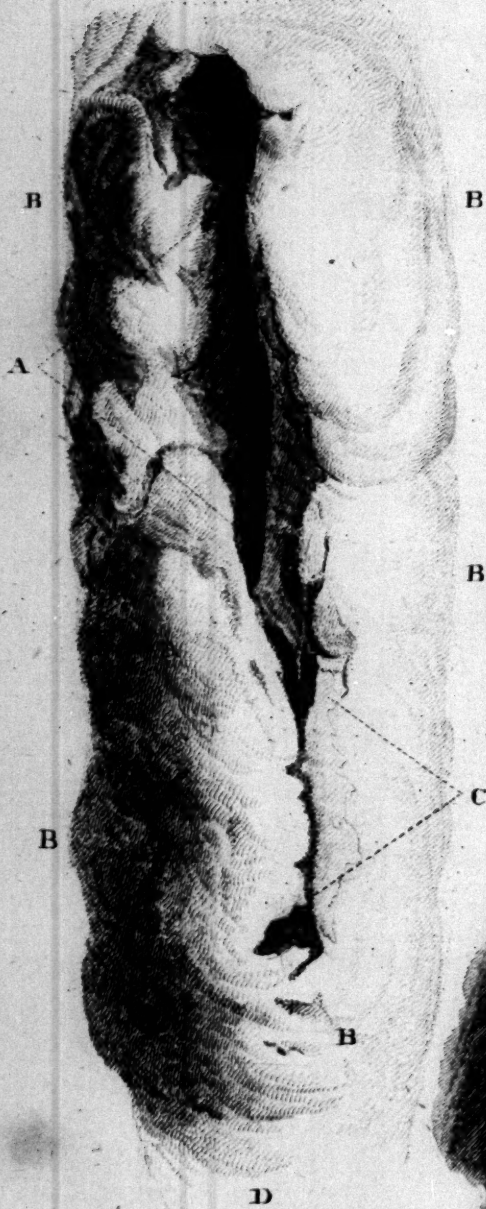


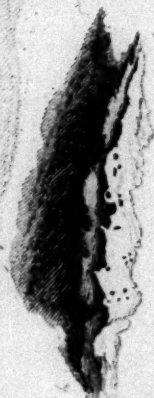
Fig. 1.



Fig. 4.



Fig. 3.



Macrodontia

Explanation.

PLATE IV.

THIS plate contains four figures, which all relate to the same case of Necrosis.

Fig. 1. represents the sequestra of a portion of the tibia, about five inches long. There is nothing singular or remarkable in this specimen. It has the prominent pointed rugged edges common to all sequestras, and it originally belonged to the limb delineated in figure second.

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This figure (Fig. 2.) exhibits a case of Necrosis under cure. A denotes the cavity from which the sequestra was extracted. B B B the ossific granulations which belong to the new osseous shell, and which are very luxuriant in their growth. At C, where the naked bone has been exposed and irritated, a thin lamella is separating by exfoliation. The exfoliated portion is represented separately in figure third. D D D, the sound part of the limb. The inspection of this figure shows with what luxuriance and irregularity the ossific granulations grow up. This drawing was taken eighteen days after the sequestra (Fig. 1.) had been extracted; yet, in this short period, the cavity is so very much filled up, that it would not have admitted a bone of more than half the diameter. And if the
 parts

parts were to continue to grow with the same rapidity, it is plain that the whole of the cavity would soon be completely obliterated. From this instance we may form a tolerable estimate of the time which would be requisite to fill a large space in the same manner, which will certainly diminish our wonder at the celerity with which a substitute bone grows and consolidates. The granulations are every where prominent, and project beyond the edge of the sound parts. And this circumstance accounts for the bulky, unshapely, and clumsy appearance, which the limb will assume after the disease is cured. These granulations begin to cicatrize, and to be covered with skin at the edges, from which the new skin makes gradual advances towards the centre, till at last the whole surface of the granula-

tions is covered. There is no natural limit to their elevation above the level of the sound parts, though in general it is not considerable before the cicatrification begins, and puts a stop to their farther growth. The bone lies at no great depth below the surface of the granulations; and whenever they are scraped off, that portion of the bone which is exposed, rarely fails to exfoliate. This is more fully expressed in figure third, which represents the lamella, (Fig. 2.), after it had separated by exfoliation. The edges of it are as thin as the finest cambrick paper, but towards the middle it becomes more solid and thick. The thin parts are perforated by a number of small holes. The separation of it was effected after the usual way, and was the consequence of the irritation which the osseous shell suffered

suffered by the removal of a small piece, to facilitate the extraction of the sequestra.

Fig. 4. represents this piece of the osseous shell, which was removed by means of a pair of cutting pliers, and which was about three-eighths of an inch thick. In other respects, there is nothing remarkable in its texture or consistence.

N 4

Explanation.

PLATE.V.

Fig.3.

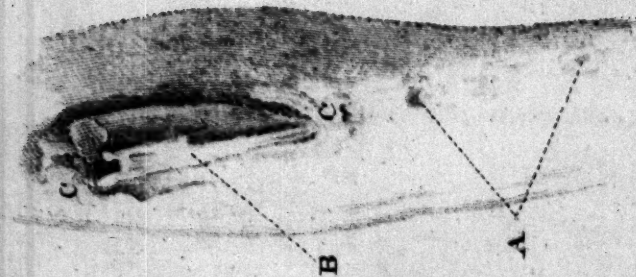


Fig.2.

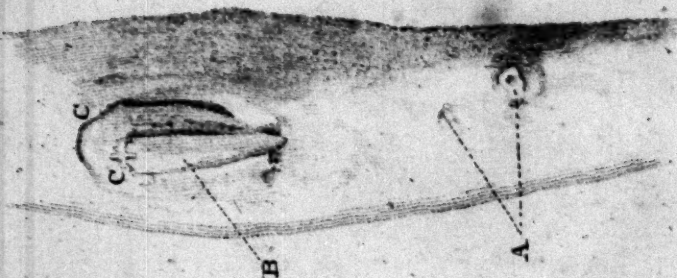


Fig.1.

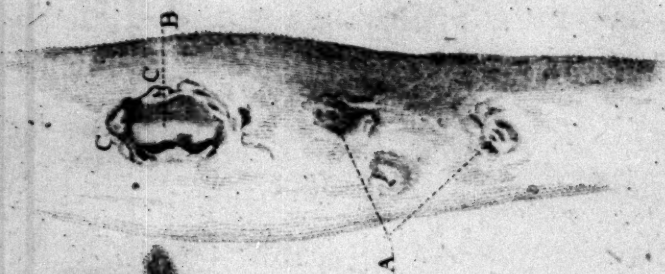


Fig.5.

Fig.4.



Fig.7.



Fig.6.



Explanation.

PLATE V.

THE three first figures of this plate show the usual appearances of a case of Necrosis, when the sequestra is visible. In figure first it is only exposed. In figures second and third, it protrudes. All the three figures agree in the representations they give of the ulcerations, and likewise of the clumsy shape of the legs, in consequence of the large size of the substitute bone. In all the three figures, the letter A indicates the external ulcerations. They are placed irregularly, in the course of the tibia, and are all of them

them elevated above the skin, in the form of small papillæ. A small portion only in the centre is of a red colour. In figure first, B represents a portion of the sequestra, bare and exposed. It is at a considerable distance from either extremity, and does not protrude through the opening in the new bone. C C, granulations connected with the new bone, which, in colour, firmness, and consistence, resemble a bit of healthy gum.

In figures second and third, B B in like manner indicates the naked sequestra. But in both these cases, the extremity of it is seen projecting a considerable way beyond the surface of the new bone. The two figures are given in order to show the progress which the sequestra makes in protruding, in the course
of

of nineteen days. Figure second is the first date, and figure third the second. In the latter the lower part of the sequestra appears farther down the leg. The extremity too is not so pointed, the sharp points having been worn down by friction. C C denotes the granulations connected with the new bone, which grow up behind, and fill up the vacancy which the sequestra leaves, as it advances forward. So that, in the case of a protruding sequestra, the cavity of the new bone is nearly filled up at the time the sequestra is ejected. Perhaps, indeed, the growth of these granulations has some share in pushing it out. It is likewise evident that a process of this kind must necessarily be slow and tedious.

Fig. 4.

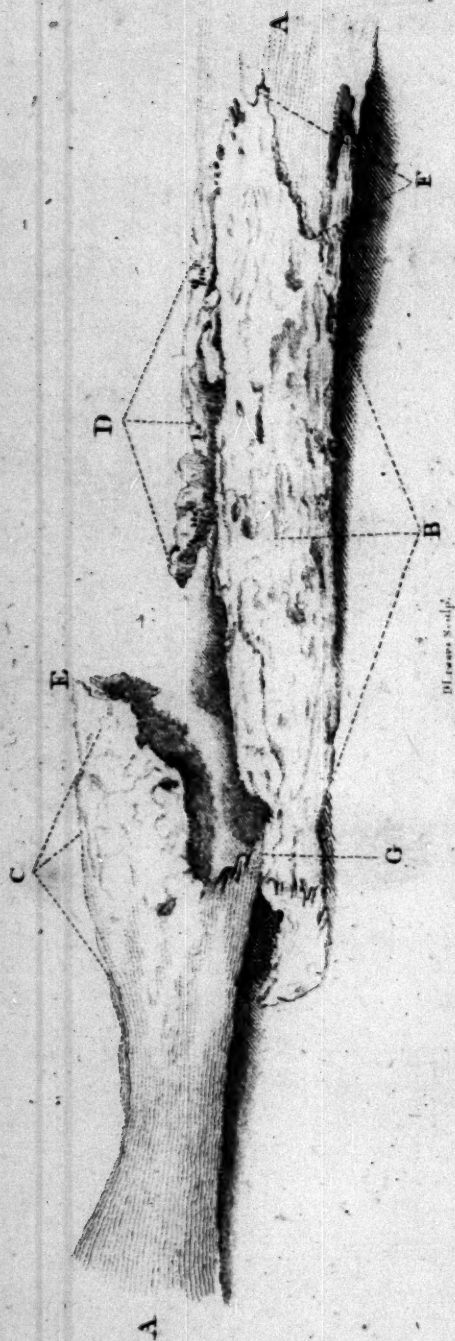
Fig. 4. a portion of the lower jaw, above the angle. The condyloid process is complete, and has the articular surface A smooth and entire. B, part of the coronoid is worn away. The patient, from whom this preparation was taken, could masticate, though not much, during the pendency of the disease.

Fig. 5. a portion of the lower jaw, near to the mental hole, in which part of the inner table is eroded ; so that the nerves and blood-vessels were not torn by the removal of this sequestra. A indicates the alveoli a little impaired by disease. B a considerable chasm in the inner part, occasioned by the erosion which made way for the passage of the nerves and blood-vessels.

Fig. 6. and 7. Portions of the new of-
seous shell of figure first, cut out with a
trephine, to permit the extraction of the
sequestra. At the thinnest part, the shell
seems to have been above a quarter of an
inch thick.

Explanation.

PLATE.VI.



Explanation.

PLATE VI.

A CASE of compound fracture, in which the cure was going on, upon the principle of a case of Necrosis. A A indicates the healthy portions of the Tibia. B B part of the Tibia, which was separating from the healthy extremity at F. C D pieces of new osseous matter, which was extending from one of the healthy extremities to the other. When this preparation was fresh, a quantity of soft matter filled up the whole interval between the extremities, and this was the bed in which the ossifications began, and which

which would at last have connected the extremities together. In this fracture, the extremities of the bones at G overlapped, and could not be replaced. Consequently, as is evident from inspection, the thickness of the bone must intervene between the upper sides of the two portions, and likewise between their under sides. So that the new growth which proceeds from the upper side of one, must be at a distance from the other, and can have no dependence on the periosteum of either. Thus, for example, the point of the ossification at E is removed, both from A, and from any part of B. It cannot possibly, therefore, originate from the periosteum. Besides, in the case from which this preparation was taken, the periosteum belonging to the whole portion B, was destroyed by inflammation, and

and so could have no share in forwarding the process. Independently, however, of this circumstance, the mechanical difficulty, in cases of compound fracture, in which the bones overlap, is of itself sufficient to prove that the union of the extremities, on the principles of Necrosis, cannot be accomplished by the periosteum.

This is likewise explained in the Text, pages 18. and 19.

FINIS.

(209)

and to be able to do so, it is necessary

that the person who is to be

examined should be in a state of

calmness, and that he should be

examined in a room which is

quiet, and in which there is no

other person present, except the

examiner and the person to be

examined. It is also necessary

that the person to be examined

should be in a state of health,

and that he should be in a

state of mind, and that he

should be in a state of

calmness, and that he should

be in a state of health, and

that he should be in a state of

calmness, and that he should

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calmness, and that he should

be in a state of health, and

that he should be in a state of

calmness, and that he should

be in a state of health, and

ERRATA.

Page 7. Catchword, and

—— 8. First word, *for these read this*

—— 75. Line 13. *for knew read know*

TO THE BOOKBINDER.

Each Plate is to front its respective
Explanation.

A B

Fig. 1.

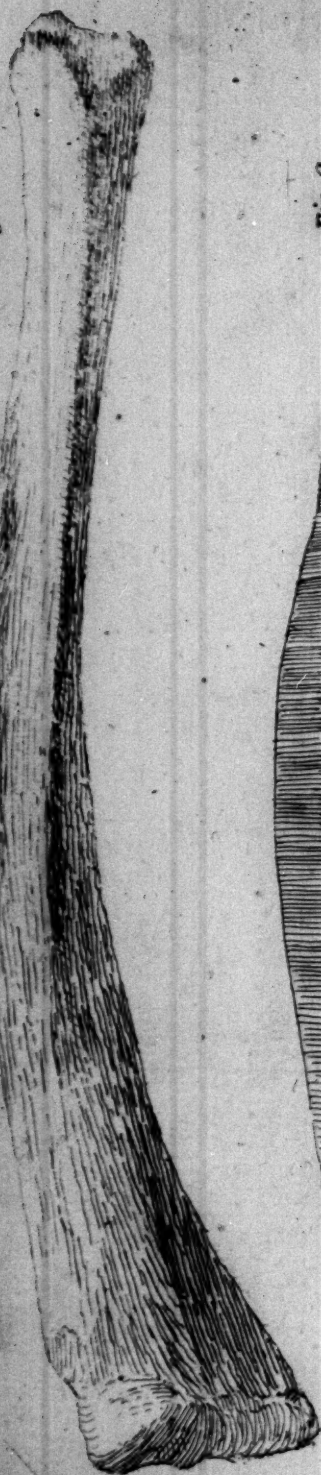


Fig. 2.

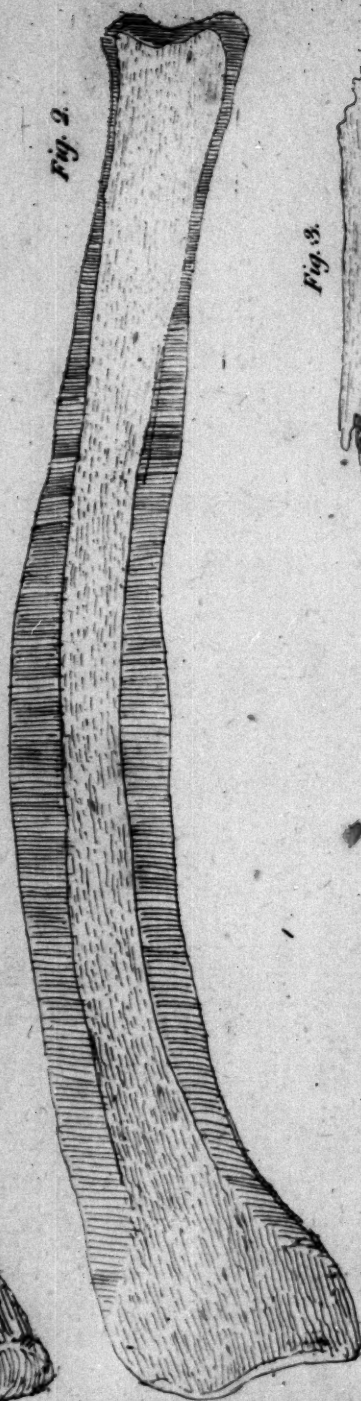


Fig. 3.



Fig. 4.



APPENDIX.

APPENDIX.

APPENDIX.

THIS short Appendix contains the history of two cases, which occurred since the materials were collected for composing the body of the Essay.

CASE FIRST.

THE first case presents an instance of a complete cure of nine years standing, in which a portion of the tibia, of about three inches in length, had been thrown out in one entire piece, and its place

completely supplied by the growth of new bone. Both the separated portion of the original tibia and the new formed substitute bone, are now in my possession, and serve to illustrate some points of the disease in a clearer manner than any other preparation which has hitherto been described. The portion of the original tibia exhibits nothing remarkable. (It is represented in Fig. 3. Plate vii. where this and the other two, the 1st and 2d, are all drawn to the scale of one half the linear measure of the original preparations.) It is plainly a portion of the complete cylinder of the bone, so that all the substance which now supplies the place which this before occupied must be entirely new growth. The patient was about six years old at the time of the attack. After an interval of nearly
nine

nine years, she died of a disease in the head, and thus afforded an opportunity to examine the state of new bone. Upon comparing the two legs together, they were found to be of equal lengths, only that one which had formerly been the seat of disease was now somewhat incurvated, being convex forward; and upon the anterior part of the leg, corresponding to this incurvation, there was an extensive cicatrix, the vestige of the large wound which had been made by the expulsion of the original bone. The skin over the whole extent of this surface was shining, thin, and attached to the bone below. After removing the integuments and other soft parts, the naked bone appeared of a regular shape, and was everywhere covered with a membrane, which adhered firmly to its sur-

face, and had all the appearance of a natural periosteum. This regularity of shape was a circumstance I did not expect, as all the former cases which I had enjoyed an opportunity to examine were recent cases, in which the new bone was still clumsy, large and unshapely. But in this case the new bone was neatly modelled, and provided with angular ridges and flat surfaces, so that it might very well pass for the tibia of a person whose bone had been somewhat distorted from an attack of rickets. (Plate vii. fig. 1. exhibits a lateral view of this bone, and shows at once its angular ridges, flat surfaces, and incurvation.) Between A and B on the fore part, corresponding to the place of the cicatrix, there is a small prominence, somewhat irregular at the edge; but this is the only

only deviation from the general regularity of shape.—These are the chief circumstances which require to be noticed in the external appearance of the bone ; but the structure of the internal parts still remained to be examined. In those cases in which the sequestra is excluded during the progress of the disease, the whole of the substitute bone is originally formed in one solid mass, without any cavity or cancelli for the lodgment of marrow. Nor do I know of any dissection on record, in which any such regular structure was found to have taken place at a period distant from the time of the attack. Mr LUDWIG, in the 3d volume of his *Adversaria*, gives an account of a case nine years from the date of the cure, in which the substitute bone

was still solid, without any appearance of a cavity in the centre. In the case now under consideration, however, the bone, upon being sawn through longitudinally, discovered a complete medullary canal, running the whole length of the bone, and to all appearance as perfect in every circumstance as it could have been in the original bone. It extends without interruption from one end to the other, expands towards the extremities, and is full of cancelli. (See Plate vii. fig. 2.) Thus the new bone appears to have attained a wonderful degree of perfection in the organization of its structure. It is modelled into a regular shape, provided with a periosteum externally, and with a medullary cavity in the centre. So this preparation

tion

tion removes every doubt respecting the state which the substitute bone is ultimately capable of attaining, and, so far as I know, is the only instance of bone having been reproduced so perfect in all its parts.

CASE

then removed every doubt respecting the
state which the substitute bone is still
entirely capable of sustaining, and, to say
as I know, is the only instance of bone
having been perfect in all

CASE SECOND.

THE second case was very different in the circumstances of its history. It occurred in the person of a patient who suffered amputation above the knee. The stump, instead of healing kindly, was attacked with partial suppurations, which extended along the course of the femur, excited great pain, and protracted the cure. Small portions of bone had been at times thrown out from the extremity of the stump; and in about eight months from the date of the operation, a much larger portion was evidently loose, and ready to come away.

It

It was easily removed, and after its removal a solid mass of bone was still found remaining behind, apparently of much larger dimensions than what the femur of such a person ought to be in its natural state. It had a large cavity in its centre, and upon examination proved to be entirely a new formation. In short, it had all the character of a substitute bone, such as forms in an ordinary case of Necrosis. It was indeed formed under unusual circumstances, and upon this account afforded an opportunity to obtain the separating portion of the original bone in a particular state of decay. The length of this portion was about four and a half inches, (See Plate vii. fig. 4.), and composed one continuous mass, which possessed a singular degree of consistence for a bone. It was so friable

able as scarcely to bear its own weight without breaking, and accordingly, upon handling, it gave way at the point C. The greater part of the mass consisted of a substance in the state of powder, which possessed very little cohesion. It seemed to be the earthy portion of the bone almost entirely deprived of its connecting medium ; and the conversion of it into this state had proceeded so far, that the original bone was everywhere reduced to the state of a thin shell, which gradually diminished in thickness towards the farther extremity E, where there was scarcely a vestige of the fabric of the original bone. In approaching towards the lower extremity of the bone A, which had been cut across with the saw, the thickness and solidity of the shell increased. At B, a small plate, similar

milar to what so often separates in the progress of a cure of Necrosis, was completely detached ; and at D, there was nothing but a mass of the powdery substance, cohering very slightly : and in all this neighbourhood, the surface was covered with nothing but thin and detached films of the original bone.—We may here trace some of the leading steps of the progress of the old bone towards decay. In the first place, it seems to be reduced to the state of a powder, by the dissolution of the uniting medium which connects the earthy particles together ; and that when the earthy portion is thus loosened and detached, it is either taken into the system by absorption, or washed out through the apertures of the new bone along with the purulent matter. But there is no appearance that the whole

whole substance of the bone is ever completely dissolved into a fluid state. It is a species of decomposition which seems peculiar to a bone under particular circumstances, and differs from the ordinary process of putrefaction, both in the celerity with which it is accomplished, and in the absence of foetor.

THE END,